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CORRECTIONS

August 1948, vol. 86, page 286, 2d column, table 1, in the heading change "July" to "August."

October 1948, vol. 86, page 320 (Tropical Disturbances, etc.), 1st column, 2d paragraph, 11th line down, for "Hawaiian S. S. *Centaur*" read "Honduran S. S. Castilla."

Same issue, in table 1 on pages 296 and 297, the heading "Cal." should be "cal." since small calories, not Great Calories, are meant.

MONTHLY WEATHER REVIEW

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A HEAT RADIATION TELESCOPE AND THE MEASUREMENT OF THE INFRARED EMISSION OF THE ATMOSPHERE

By WALTER M. ELSASSER

[California Institute of Technology and U. S. Weather Bureau, November 1940]

1. *Historical note.*—The instruments which have been constructed to measure sky radiation are of two types. First, there are devices which measure the total radiation coming in from the sky at all angles. In their simplest form they consist of a black horizontal plate exposed to the sky and mounted next to another plate which is either shielded from the sky or has metallic reflectivity; the difference in temperature of the two plates is measured by means of a thermocouple. In order to avoid condensation on the black plate during the night and also in order to minimize the effect of turbulent heat conduction through the air, it is advantageous to balance the temperature difference of the two plates by heating the colder plate electrically until the temperatures of both plates are equal. The square of the heating current measures the amount of heat supplied to the cold plate per unit time which in turn is equal to the heat lost by radiation. Instruments of this type have been constructed by Ångström, Albrecht, Ramanathan, and others. (1) In the melikeron (honeycomb) constructed by Aldrich of the Smithsonian Institution (2), the black plate is replaced by a grid formed by blackened strips of thin metallic foil. The strips are standing on edge and the honeycomb thus resulting is "blacker" than a simple horizontal plate since any radiation scattered by the absorbing surfaces has a higher probability of hitting an opposite surface than of escaping back to the sky. Two instruments of this type have been in use by the United States Weather Bureau.

The second type of radiation instrument measures only the radiation coming from a given part of the sky. In its simplest form the instrument consists of a black plate located at the bottom of a box without top; and the effective radiation comes only from that fraction of the sky which is visible to the black plate. Usually the box is more or less tapered toward the lower end. By means of this arrangement the intensity of the incoming sky radiation can be measured as a function of the angle of elevation. Instruments of this type have been built by Dines (3) Dubois and Linke (4) and F. A. Brooks (5). Linke (4) has furthermore shown that the following approximate relation holds for the effective radiative heat loss E of an unobstructed horizontal black plate, E being expressed as fraction of the total black body radiation emitted by the plate:

$$E=\frac{e_0}{1+1.66\log_{10}(e_1/e_0)}.$$

Here e_0 is the fractional radiative loss toward the zenith; $e_0=(b-s)/b$ where b is the black body radiation emitted by the plate into a solid angle around the zenith and s is the radiation received from the sky in the same solid angle and e_1 is the same quantity for a direction inclined by 60° relative to the zenith. Since this formula is found to yield E with a high degree of accuracy, it is practically sufficient to make two readings with a shielded instrument in order to obtain the total sky radiation. Hence, with regard to the quantitative determination of the total incoming radiation, there is no distinct advantage in the use of any one type of instrument. The instrument with a limited view will of course have a smaller change in temperature than the one with complete exposure and this necessitates the use of a galvanometer of higher sensitivity. It seems however that in protecting the plate from atmospheric eddies by means of the surrounding box a smoother operation of the instrument is insured in spite of the more sensitive galvanometer required.

2. *The instrument.*—In our instrument the receiving black plate and a compensating plate are located in the focal plane of a concave mirror (fig. 1), a construction first used by P. Dubois (6). The "plates" are tiny silver disks. The mirror was obtained by aluminizing (7) one side of a concave lens of 7.5 cm diameter; and it has a focal length of 10 cm. The tube of the telescope has an overall length of 44 cm. The disks are mounted inside a central tube of 1.2 cm diameter which also contains an eyepiece of a design that may be recognized from figure 1. The observer who looks into the eyepiece sees the disks simultaneously with the object toward which the telescope is directed. The central tube and eyepiece are fastened to a tube which slides inside the main tube of the telescope and focal adjustment for objects of various distances is made by means of a screw drive which, for the sake of clarity, has been omitted from figure 1. The ribs holding the central tube and this tube itself are of copper, while the remainder of the instrument is of brass. The use of copper insures a rapid equalization of temperature differences in the central part. One of the three copper ribs holding the central rod is especially heavy; it leads to a copper block which projects to the outside through a slot in the outer tube and which contains the bulb of a sensitive thermometer. By means of this connection it is possible to obtain accurately the temperature of the central tube from a reading of the thermometer. The instrument is suspended in a rectangular gavel and it can be rotated around a horizontal and a vertical axis, the finer regulation being made by means of adjustment screws. A vertical protractor is provided to be used for sky radiation measurements. The whole instrument and gavel are nickel-plated in order to minimize radiative heating or cooling of the instrument. The instrument together with tripod and switch-boxes can be folded to fit into a wooden case the size of an average suit case.

The receiving unit, as it appears on looking through the eyepiece, is shown in figure 2. The receivers are two silver disks 1.2 mm. in diameter and 0.13 mm. thick. They are blackened with zinc black deposited by sputter-

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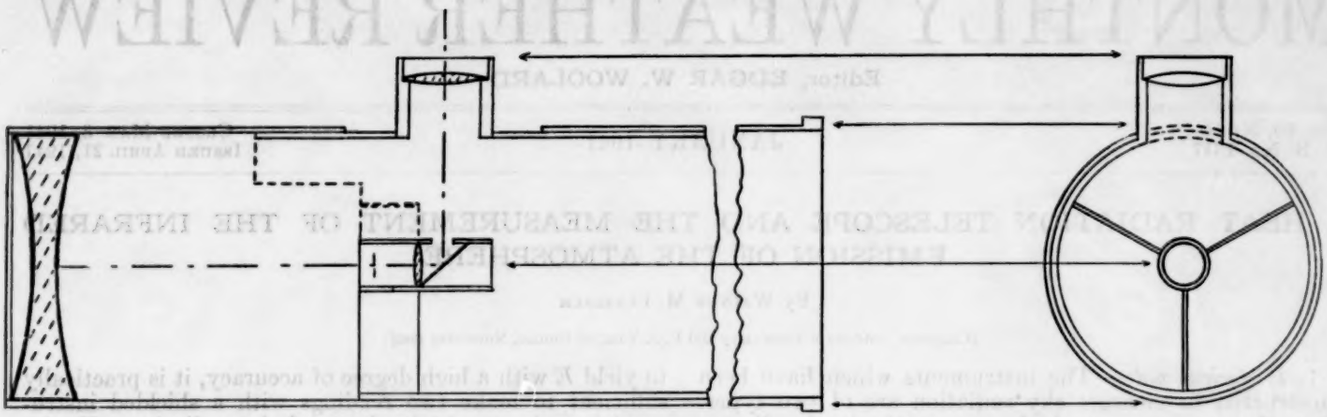

FIGURE 1.

ing under reduced pressure after the method of Pfund (8). This method yields extremely black surfaces; according to tests which extend from the visible region to a wavelength of 11 μ it is practically completely (98 to 99 percent) black over this whole interval, and it can, therefore, in all probability, be assumed to be black for the remainder of the spectrum. While this method of blackening is not applicable to open surfaces, as the black can be wiped off easily, it has distinct advantages in encased receivers. Its heat conductivity is much higher than that of soot and other conventional forms of optical black; this minimizes the temperature gradient across the coat of blackening, and the effective radiative temperature of the black surface will be nearly the same as that indicated by the thermocouple.

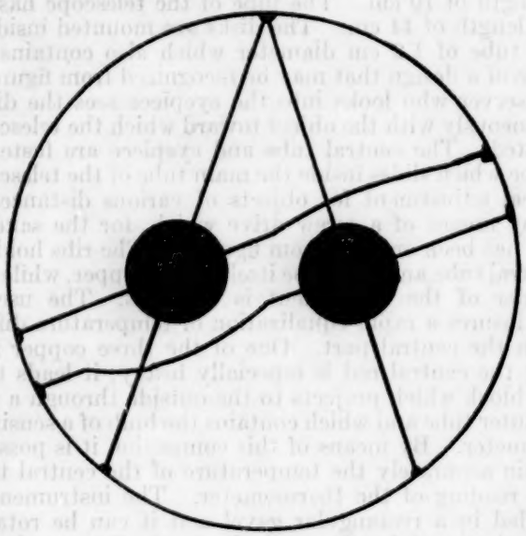

FIGURE 2.

Two wires are seen crossing each disk in figure 2. One is a thermocouple while the other is a heating wire by means of which the cooling of each disk can be compensated by electrical heating. The thermocouple consists of a constantan-manganin combination, the wires being 0.03 mm. thick. While this element has only 40 microvolts per degree, an electromotive power considerably less than some other thermoelectric combinations, the wires are drawn wires and have an extremely high mechanical stability. Furthermore, the resistance and the electromotive force of this couple are very insensitive to temperature changes. The couples are soldered to the silver disk. The two couples together form the V-shaped figure seen in figure 2; they are used in series with opposite polarities, measuring thus the temperature difference between the disks. The constantan wires form the tip of the V, while the manganin wires are at the open ends. If the two couples are used in series in this manner, the cold junctions are formed by the two copper-manganin combinations at the open ends; as the thermoelectric force of this combination is exceedingly small, the influence of a temperature gradient between the cold junctions is greatly reduced. An outside connection of the constantan junction is provided, however, so that each couple may be used individually if desired. There is found to be an appreciable thermal coupling of the two disks by conduction through the air; if one of the disks is irradiated, the other disk will change its temperature by about one third of the change of the first disk.

The heating wires are made of constantan wire of the same thickness. A tiny speck of brass foil is soldered to their middle and this foil is pasted to the back of the silver disk with glyptol. The heating circuit is everywhere completely insulated from the thermocouple circuit.

Each of the thermocouples has a resistance of about 5 ohms. The galvanometer used was a Leeds and Northrup high-sensitivity galvanometer with the following characteristics: Internal resistance 19 ohms, critical damping resistance about 10 ohms; with critical damping resistance in series and with the scale at 2 m. distance, as the instrument was normally used, the sensitivity is about 2 mm. per 10^{-7} volts. The telescope is connected with a control unit by a cable of 5 m. length. The control unit consists of a set of switches for the thermocouple circuit and a switchboard with rheostat for the heating circuit. The heating wires are shunted by a very low resistance so that the total current flowing in the heating circuit is of the order of several hundred milliamperes; it can be read from an ordinary Weston milliammeter. The voltage is supplied by a 2-volt storage battery.

3. *General tests.*—The instrument is calibrated in terms of the compensating current by making one disk look into a bottle with liquid air. For this purpose the instrument is provided with an attachment tube 30 centimeters long and of about the same diameter as the main tube of the telescope. The attachment is closed by an aluminum plate with an excentric hole; and if the instrument is focused upon this plate, the image of the hole is seen to be covered by one disk (the image of the hole being somewhat larger than the disk) so that this disk exchanges

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radiation with the liquid air while the other disk receives radiation only from the reflective surface of the aluminum. The second disk may therefore be assumed to be in radiative equilibrium with and at the same temperature as the body of the telescope. For calibration the interior of the instrument is filled with air which is dry and free of carbon dioxide. Such air can be produced by letting liquid air evaporate, warming it to room temperature and then leading it to an inlet provided at the attachment. It is found that after about 20 minutes all the moisture is removed and the reading of the instrument becomes constant under continued flow of the dry air. The deflection of the galvanometer for liquid air and 20° room temperature was about 170 millimeters with the scale at 2 meters distance. All galvanometer readings were made to a tenth of a millimeter. It was found that the reading did not depend upon the angle under which the surface of the air is sighted. This result was interpreted to mean that there could be no appreciable amount of radiation of room temperature reflected at the surface of the liquid air. As a check the temperatures of several mixtures of dry ice and alcohol, ranging between −60° C. and −20° C., was measured. The radiation calculated by Stefan's law from the temperature of the bath as indicated by a thermometer and the radiation measured by the instrument agreed always to within 1 percent. Temperatures close to room temperature can readily be measured; the observed deflection is of the order of 2 millimeters per degree temperature difference between the instrument and the object. If the radiation of extended objects, such as water, snow, or the sky is to be measured, it is convenient to use the attachments described before. The effective radiation then forms a bundle converging toward the instrument with an opening angle of about 8°. To measure the radiation from smaller objects it is necessary to focus the instrument upon them and to have the second disk covering an object of known temperature. For this a round piece of paper was used which assumes the temperature of the surrounding air. If the object is near the instrument, the paper is put at approximately the same distance as the object; for distant objects it is sufficient to have the paper at a distance of about 15 feet. We might note here that any change of focus produces a change in illumination of the disk and hence measurements of objects at different distances must be corrected for this change in order to be comparable. This purely geometrical quantity can readily be calculated from the distance of the object; it was also directly verified by a set of check measurements. In all cases of temperature measurements of distant objects a correction has also to be applied for the emission of water vapor and carbon dioxide in the optical path between the instrument and the object. This correction may be taken from figure 4 and is discussed below.

In order to study the behavior of the instrument in field measurements, it was set up on the flat roof of the California Institute of Technology during several evenings. The attachment was removed so that the telescope was open to the air at one side. It can be closed by means of an aluminum shutter. It is found that if the instrument is either closed by the shutter, or if it is open and both disks are simultaneously pointed at the same wall or at the sky, there will be a zero deflection of the galvanometer which usually keeps between 2–5 millimeters, but which changes only very slowly in time. This effect is mostly due to a temperature gradient established across the central tube of the instrument after the latter has reached a steady thermal state. If a measurement is made by reading first the zero with closed shutter, then opening the shutter for about 45 seconds and then reading the zero again after the shutter has been closed for another 45 seconds, there is usually only a difference of 1–3 tenths of a millimeter between the two zero readings, which corresponds to only a fraction of a percent of the black body radiation at air temperature. There seems to be little difference in the stability of the instrument whether the shutter is open or closed. Conditions in southern California are of course very favorable, the air being rather quiet, but it may be concluded that if the instrument is used for sky radiation measurements with the attachment in place, which gives much additional protection, it will give good results even when a strong wind is blowing. In order to avoid fluctuations due to adiabatic compression of the air such as produced by gusts in the open air or by the opening and shutting of a door in a room, the disks were made much heavier than is customary for thermocouple receivers so that they take about 45 seconds to reach full equilibrium (the sensitivity at equilibrium is however not affected hereby) and they were made as rigorously alike as possible by cutting them in a lathe from a silver foil. It is found that when both disks are exposed to liquid air simultaneously in a quiet room, the resulting galvanometer deflection is only a fraction of a millimeter.

While in most respects the instrument met expectations, it was found that the use of a compensating heating system is not entirely advantageous in this type of instrument.

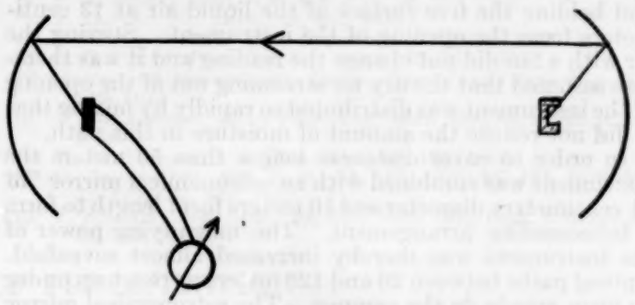

FIGURE 3.

It was originally thought that it would supersede the necessity of recalibrating the instrument and galvanometer in position each time, but this expectation was not fulfilled. This is probably at least in part due to the fact that the shunts which parallel the heating wires are extremely low resistances and unless they are soldered with extreme precision they are liable to change slightly under mechanical shaking or temperature changes. The heating system is somewhat clumsy in actual operation. It is contemplated to remove it in the future. For accurate measurements the instrument must be calibrated each time; in the experiments described below, it was recalibrated with liquid air at the beginning and end of each working evening. It was found that for ordinary field work, such as sky radiation measurements, it is quite sufficient to calibrate by aiming into a thermos bottle filled with water of a temperature about 30°–40° C. above that of the instrument and correcting for the absorption of the water vapor in the optical path between the warm water and the receivers.

4. *The emissivity of water vapor.*—While the instrument can be used to measure sky radiation and the radiative temperature of distant objects, it was constructed for the immediate purpose of determining the emissivity of moist air by the Hottel method (8). The principle of this method is indicated diagramatically in figure 3. The system at the left of figure 3 represents the receiving instrument. To

the right is another concave mirror at the focus of which a black body is placed that is kept at the temperature of liquid air. The instrument is focused upon this mirror in such a way that one of the disks will be seen to cover the magnified image of this black body. Now the radiation originating from the latter is extremely small due to its low temperature; it amounts to only a percent of the black-body radiation at room temperature. The radiation falling upon the disk is then equal (apart from this small amount emitted by the black body) to the *emission* of the column of moist air traversed by a ray originating at the black body and ending at the receiving disk.

The mirror used was a standard army searchlight mirror of 75 centimeter diameter [1] which was aluminized at the front side.[2] The black body consisted of a hollow piece of copper connected to a piece of heavy copper tubing which emerges from a thermos bottle filled with liquid air. It was found by tests that, if the bottle is freshly filled, the radiative temperature of the black body as measured by the instrument is indistinguishable from that of liquid air. By means of this set-up it was possible to measure the emission of moist air for distances between the insturment and the searchlight mirror ranging from 3 meters up to 50 meters. Smaller distances were measured by looking directly into a flask filled with liquid air. The smallest distance measured was 13 centimeters; this was obtained by filling the instrument and the attachment with dry air and holding the free surface of the liquid air at 13 centimeters from the opening of the instrument. Stirring the air with a fan did not change the reading and it was therefore assumed that the dry air streaming out of the opening of the instrument was distributed so rapidly by mixing that it did not reduce the amount of moisture in this path.

In order to cover distances longer than 50 meters the instrument was combined with an astronomical mirror [3] of 54 centimeters diameter and 10 meters focal length to form a telescopelike arrangement. The magnifying power of the instrument was thereby increased almost sevenfold. Optical paths between 20 and 120 meters were set up under an open arcade on the campus. The astronomical mirror was then mounted on a concrete block in a park opposite the campus and a maximum optical path of 315 meters was obtained.

As is well known, the moisture near the ground has an appreciable vertical gradient due to turbulence and evaporation. The optical path was about 5 feet above the ground and it was technically difficult to go higher. The following method was therefore adopted to measure the moisture content in the path. A glass bottle holding 20 liters was evacuated and if a stopcock was opened, air would stream into the bottle. The air would first go through a collecting tube, then through a U-tube filled with phosphorous pentoxide and finally through a capillary to reduce the rate of flow. The phosphorous pentoxide was weighed before and after each filling of the bottle. The bottle was mounted on a toy truck and an assistant would carry it along the path holding the collecting tube as accurately as possible at the height of the optical path. By using two or three bottles in turn it was possible to obtain 5–6 representative samples of the moisture during each evening at which a measurement was made. The measured values of the moisture show surprisingly large fluctuations which cannot be ascribed to errors of measurement, but represent almost certainly an eddy structure of the air. Fortunately the infrared emissivity is very insensitive to small changes in moisture content.

[1] Loaned by the Otto K. Oleson Co. of Hollywood.
[2] In the optical shop of the Astrophysics Department of the California Institute.
[3] Loaned by the Mount Wilson Observatory.

Our results are represented in figure 4, where the emissivity of water vapor is expressed in percent of the black body emission for 20° C. Abscissa is the logarithm of moisture in grams per cm.^{2} The carbon dioxide emissivity as measured by Hottel and Mangelsdorf (**9**) with the same method is also given, and the fraction of the emission due to the carbon dioxide in the path was subtracted from the experimental results. Corrections were also made for the reflectivity of the aluminum surfaces which was determined by separate exper ments (about 3 percent loss per reflexion) and for the deviations of the air temperature from 20°. The latter correction was small, as in all experiments the air temperatures were between 15° and 25°. All the points which were measured are entered in figure 4 with exception of those obtained on the first two evenings where the optical adjustment was found inadequate, and two later points which were quite obviously in error.

These results provide a check on the atmospheric radiation chart constructed by the writer (**10**). The dashed curve in figure 4 indicates the water vapor emissivity according to the chart. As the chart gives the radiation of slabs of moist air with horizontal stratification, while our measurements yield the emission of a linear column, the two sets of values are not immediately comparable.

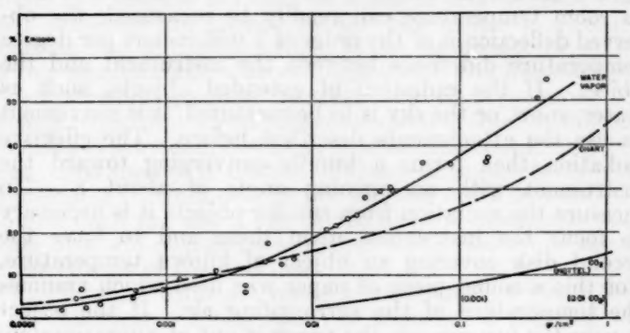

FIGURE 4.

The dashed curve was obtained by taking as optical thickness twice the thickness of the slab indicated in the chart. It is seen that for short paths there is excellent agreement between calculated and observed values. For longer paths there is a rather serious discrepancy, the calculated values being too small by 10 to 15 percent of the black body intensity. This must be attributed to too small a value for the intensity of the 6μ absorption band. As pointed out before (**10**) the inaccurate knowledge of the strength of this band was the main handicap in getting reliable quantitative information about the effects of radiative transfer in the atmosphere. It is now planned to use these results as a basis for a second, improved edition of the radiation chart. While a number of results derived from the application of the chart (**11**) must undergo minor changes of a quantitative nature, it is apparent that the discrepancies now revealed are not so pronounced as to necessitate a change of the fundamental results derived from the study of atmospheric radiation. It must appear that the mean cooling in the cloudless atmosphere will still be approximately a linear function of the logarithm of the specific moisture (*l. c.*); only the numerical coefficients will be slightly different. There remains also the general result derived, namely, that the atmosphere is cooled everywhere and is heated nowhere by infrared radiation. The discussion of these conclusions is however not within the scope of the present note.

Finally, our results may be compared to those of similar experiments carried out by Falckenberg (**12**) which extend over a more limited range of moisture. Falckenberg's values for the emissivity are much higher than ours, for instance for 0.0005 gr/cm² of water he finds 6.7 percent emission, for 0.0015 gr/cm² he has 13.4 percent, and for 0.0075 gr/cm² he has 17.5 percent, the figures referring to the same temperature of 20° for water vapor as ours. On the other hand, we might derive some information from the results obtained by Hottel and Mangelsdorf (**9**) on steam. The values of the latter work are intermediate between those of Falckenberg and ours. Now general spectroscopic evidence indicates (and this will also be seen from the numerical values in the radiation chart) that between 0° C. and 100° C. the percent emissivity increases with increasing temperature for the thicknesses of moisture considered here. The values for steam ought therefore to lie above our values, as is observed, while an experimental error in Falckenberg's values seems indicated. For the same interval of moisture, Schnaidt (**13**) has calculated the emissivity on the basis of spectroscopic data partly independent of those used in the construction of our radiation chart and his results are in close agreement (within ± 1–2 percent of the black body intensity) with our measured curve.

Conclusion.—The experiments carried out by us seem to indicate that there are a number of advantages in using for the measurement of atmospheric radiation the closed type radiation instrument with a concave mirror. Two ways seem to be open to increase the sensitivity of the instrument. While our mirror covers a solid angle which is about 8 percent of the maximum solid angle of 2π, it should be possible without much difficulty to grind a short focus mirror covering about one-half of the hemisphere. Furthermore multiple junction thermopiles might be used, although it is perhaps difficult to compensate them as well against temperature changes due to adiabatic compression of the air as one can compensate the one-junction type and the use of the latter might remain more advantageous.

During a clear autumn night an hour-to-hour record was made of the radiative temperature of the foliage of several trees, one of them an orange tree. Simultaneously the radiative temperature of a piece of bare ground and the sky radiation were recorded. While the radiative temperature of the ground was consistently below the air temperature by about 0.8° C. from early evening until sunrise, the temperature of the tree foliage showed an irregular deviation from the air temperature of only a few tenths of a degree, which is within the observational errors. The dew point was however very close to the air temperature during the whole night, so that it is hardly possible to apply this result to the dry polar outbreaks during which the freezing of orchards occurs.

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THE VARIABILITY OF PRECIPITATION

By V. CONRAD

[Pennsylvania State College, State College, Pa., October 1939]*

In some years on Malden Island, precipitation amounts to 100 millimeters (3.94 inches), and in others to 2,000 millimeters (78.8 inches) and more. The mean of many years amounts to 727 millimeters (28.6 inches). The relative variability is 71 percent.[1] This is the most extreme case on the earth, as far as known. From the geophysical, meteorological, and climatological standpoint, such variations of precipitation are of great interest. The possibility of years with floods, with abundant crops, and of years with famines at the same place indicates great variability, the explanation of which is a problem for the above sciences.

In the present paper the variability of precipitation is discussed, from a statistical point of view.

If the mean yearly sum is called $\overline{p}$ and the individual yearly sum p_i, then

$$p_i - \overline{p} = \epsilon_i.$$

The expression

$$\frac{\Sigma \epsilon_i}{n} = v_a$$

is called *absolute average variability*. It is clear that v_a must increase with $\overline{p}$. The geographical distribution of v_a would therefore give the same picture as the precipitation map itself. Hence v_a should be expressed in percent of $\overline{p}$. The quantity

$$v_r = \frac{100 v_a}{\overline{p}}$$

is called the *relative variability*; it appears to be the best measure of variability.

The geographic distribution of v_r is so remarkable that a detailed investigation is desirable.

1. THE ABSOLUTE VARIABILITY

The places with yearly precipitation 0–200, 201–400, 401–600 millimeters, etc. (0–7.9, 7.91–15.7 inches, etc.), were grouped. For each group both the mean yearly sums ($\overline{p}$) and the absolute variabilities (v_a) were averaged. If the average variabilities are plotted against the mean precipitation (table 1), a linear connection is clearly indicated. The data may be closely represented by the equation:

$$v_a = 36 + 0.13\overline{p}$$

The differences "observed–calculated" (o–c) appear in the last column of table 1. As the values of v_a and $\overline{p}$ are derived from observations over the whole earth, the above equation may be regarded as the normal relation.

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[1] E. Biel, Die Veränderlichkeit der Jahressumme des Niederschlags auf der Erde. *Geogr. Jb. aus Oesterreich*, XIV & XV, Leipzig, 1929, 151–80.

TABLE 1.—*Absolute variability of precipitation as function of the yearly sum*

Number of stations	Interval	Mean yearly sum	Average variability		o–c
			Obs.	Calc.	
	mm.	mm.	mm.	mm.	
28	0–200	127	48	53	−5
39	201–400	317	75	77	−2
60	401–600	447	95	107	−12
61	601–800	698	130	127	+3
35	801–1,000	901	156	153	+3
43	1,001–1,200	1,093	178	178	0
29	1,201–1,400	1,301	213	205	+26
27	1,401–1,600	1,505	240	230	+10
7	1,601–1,800	1,678	248	254	−6
7	1,801–2,000	1,898	276	283	−7
15	2,001–2,400	2,167	308	318	−10
13	2,401–3,000	2,663	356	382	−26
11	3,001–4,000	3,363	498	473	+25
6	>4,000	6,598	892	894	−2

2.—THE RELATIVE VARIABILITY

Now, since $v_r = 100 v_a \bar{p}$, we have

$$v_r = \frac{3600}{\bar{p}} + 13.$$

Therefore, v_r is a function of $\bar{p}$ which has the form of a hyperbola. For $\bar{p}=0$, v_r becomes infinite: For the present purpose it is important to follow the trend of the curve on the basis of the figures in table 2.

The v_r curve is extremely sensitive to small variations of the yearly precipitation in the range of little precipitation. The sensitivity is so great that it is out of proportion to the accuracy of observation. The other branch of the hyperbola is practically parallel to the axis from 1,500 millimeters (59.1 inches) precipitation to the greatest known extremes; i. e., *starting from 1,500 millimeters (59.1 inches), the variability of the yearly precipitation v_r is independent of the yearly sum.*

TABLE 2.—*Numerical Values from the Equation* $v_r = \frac{3600}{\bar{p}} + 13$

$\bar{p}$	v_r	$\bar{p}$	v_r	$\bar{p}$	v_r
mm.	Percent	mm.	Percent	mm.	Percent
0	∞	110	46	300	25
10	373	120	43	350	23
20	193	130	41	400	22
30	133	140	39	500	20
40	103	150	37	600	19
50	85	160	34	800	17
60	73	180	33	1,000	17
70	65	200	31	1,500	15
80	58	220	29	2,000	15
90	53	240	28	4,000	14
100	49	250	27	8,000	13
				12,000	13

In the case of investigations of less accuracy the limit of dependence can perhaps be moved back to 1,000 millimeters (39.4 inches). The theorem can also be expressed as follows: *the deviation of the variability from their nearly constant average value (15–13 percent) must be explained geophysically, not statistically.* But in the case of *yearly sums below 1,000 millimeters (39.4 inches) a very strong mathematical dependence of the value v_r on the yearly sum occurs:* v_r increases to infinity if the yearly sum becomes zero. In that range the expression v_r is therefore not suitable for the representation of the variability of the precipitation.[2] *In Nature* the relative variability does not increase as rapidly as would be expected from its mathematical derivation. An evidently *finite* increase of v_r results when $\bar{p}$ decreases to zero.

Therefore, I tried to find a function which changes the character of the theoretical curve as little as possible but fits the observations at the same time. The new function must have the form $\frac{A}{\bar{p}+B}+C$ instead of $\frac{A}{\bar{p}}+C$, the theoretical form, A, B, C being constants. The best value of B was found most quickly by an empirical trial method which I developed for a seismic problem many years ago.[3] It gives the average yearly sums and their v_r values in table 3.

TABLE 3.—*Mean Yearly Sums of Precipitation ($\bar{p}$) and the Corresponding Mean Relative Variabilities (v_r)*

$\bar{p}$	$\bar{p}$	v_r
Inches	Millimeters	Percent
5.0	127	37
12.5	317	24
21.5	547	17
27.5	698	19
35.5	901	17
42.9	1,093	16
51.2	1,301	18
59.4	1,505	16
66.1	1,678	15
74.8	1,898	15
85.4	2,167	14
104.7	2,663	13
132.3	3,363	15
259.8	6,598	14

The following constants have been used in the formula: $B=20$, 50, 60, 70, 100, $A=3{,}600$, and $C=13$. There was no reason of course to change the values of A and C. The v_r have been calculated with each of the five formulas, and the differences (obs.-calc.) computed for the interval of $\bar{p}$ from 0 to 200 millimeters (0–7.9 inches). This is the critical interval which makes the introduction of the constant B necessary. Then the deviations (o–c) have been summed up for the various constants B, disregarding the signs. These sums were plotted against the accepted values of B in a diagram, figure 1.

The curve shows a conspicuous minimum between $B=50$ and 60, nearer to 60. In the first approximation. The $B=60$ may be considered as the best constant. The equation is therefore

$$v_r = \frac{3600}{\bar{p}+60} + 13.$$

It follows that $v_r=73$ percent for $\bar{p}=0$, instead of $v_r=\infty$.

From table 4 we get the definitive normal values of v_r for the corresponding values of $\bar{p}$, based on the above formula.

TABLE 4.—*Definitive values v_r for increasing $\bar{p}$*

$\bar{p}$	v_r	$\bar{p}$	v_r	$\bar{p}$	v_r
mm.	Percent	mm.	Percent	mm.	Percent
0	13	140	30	700	18
10	64	150	30	800	17
20	58	160	29	900	17
30	53	180	28	1,000	16
40	49	200	26	1,500	15
50	46	220	25	2,000	15
60	43	240	25	3,000	14
70	41	260	24	7,000	14
80	39	280	23	8,000	13
90	37	300	22	12,000	13
100	35	350	21		
110	34	400	19		
120	32	500	18		
130	31	600	18		

[2] It is to be emphasized that according to W. Meinardus (Die Areale der Niederschlagsstufen auf der Erde, *Petermann's Geogr. Mitt.* 1934, 141) 53.7 percent of the earth's surface receives less than 1,000 millimeters precipitation. This fact puts the above conclusion in a new light.

[3] V. Conrad, Einsätze in Fernbebendiagrammen. *Gerlands Beiträge Geophysik.* 24, 1929–30, 358.

The formula adapted to the observations yields a curve which is practically identical with the "theoretical curve" (table 2) starting from 400 millimeters (15.7 inches) precipitation. Starting from 700 millimeters (27.6 inches) both curves are really identical.

THE ANOMALIES OF VARIABILITY

The aforesaid conditions lead, as in the case of other phenomena,[4] by necessity to the use of the method of anomalies. The anomalies should presumably be independent of the yearly precipitation and therefore adapted to show new and individual features. If two elements are as closely correlated as precipitation sum (up to about 1,000 millimeters annually) and variability, one cannot expect more information from both elements than from just one. E. Biel has (*l. c.*) published an extensive table which contains the geographic ordinates, the yearly precipitation, and the absolute and the relative variabilities for a number of places. If we use the values of table 4 as normal ones, the differences "obs.-calc." can be computed. These are the *anomalies* which appear in the last column of table 5; *these values* have been calculated here and *are new*. To facilitate the use of the table $\overline{p}$ and v_a are here also given in inches, the heights also in feet. The other numbers are taken from Biel's table.

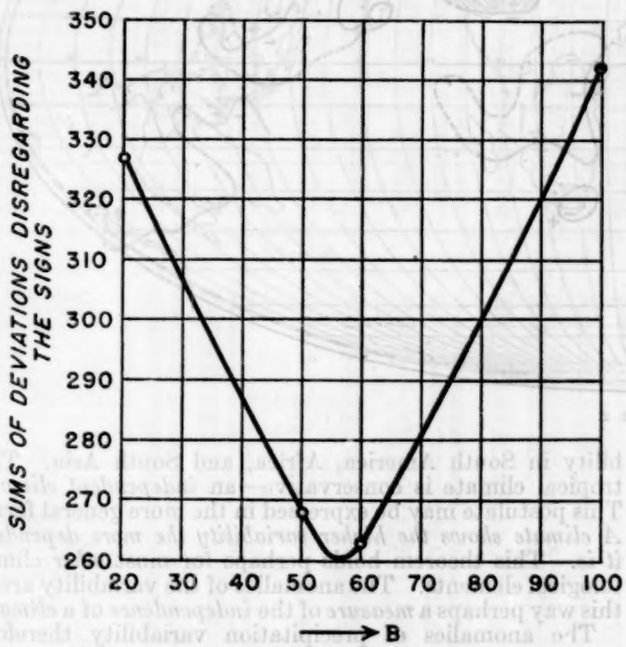

FIGURE 1.—Diagram for finding the best-fitting constant B in the formula $s_r = \frac{A}{p+B} + C$.

4. SOME STATISTICAL CHARACTERISTICS OF THE ANOMALIES

The anomalies are characterized like many other climatological elements by a certain asymmetry. Among 360 anomalies, 167 have a positive sign and 193 a negative sign —46 and —54 percent, respectively. In the dry regions the relation seems to be inverted. In the interval 0–200 millimeters (0–8 inches), we find 63 percent *positive*, and 37 *negative;* but the total number in the interval is only 27. A similar inversion appears also in the interval 1,201–1,400 millimeters (472–551 inches). In the first case it is possible to find a general and rational explanation; in the other case regional conditions may be the cause.

The arithmetical sum of the anomalies must be about zero. The asymmetry relative to the signs results in a compensation: the positive anomalies must be of greater amount than the negative ones.

This conclusion is also confirmed by statistics. The highest observed anomaly reaches the positive value of 53 percent (Malden Island). The positive maxima of the various intervals are on the average 2.3 times larger than the negative ones. Among the positive anomalies ⅓ is greater than, or equal to 10 percent; among the negative ones, only 1/10. The greatest negative anomaly is only 14 percent. Generally, *positive anomalies are on the average less frequent but more intense than negative ones.*

Finally, it is important that *the anomalies are still correlated to the precipitation sums.* Even if the material is not sufficient to determine a function which connects both elements, the fact itself is remarkable. It seems that high anomalies are very frequent in dry regions. Between 1,800 and 2,200 millimeters (709–866 inches) the curve (anomaly-precipitation sum) probably reaches a minimum and increases again with further increasing sums. Similar conditions may also exist if positive and negative anomalies are segregated, and the resulting series correlated with the precipitations; but the dispersion is so great that this relation cannot be regarded as settled.

Now arises the question: Should we prefer the representation given by the anomalies to that by the relative variability in spite of the fact that *both* show a connection with the precipitation sum *at least* in *dry regions.*

In the case of the relation *"sum-relative variability"* there is a mathematical *statistical connection* so that the relative variability can be calculated from its definition in good accordance with the observations. The relation *"anomaly-precipitation sum"* deals with a *physical relation* which cannot be calculated in advance, particularly not the sign. These facts indicate the necessity of the transition from the representation of the variability itself to that of the anomalies.

5. THE ZERO-ISANOMALS OF THE RELATIVE VARIABILITY IN CARTOGRAPHIC REPRESENTATION.

A few remarks on the anomaly map are desirable:

(1) The material is not yet sufficient; therefore detailed isanomals could not be drawn.

(2) Variability values are, of course, not available for the oceans.[5]

There are no less than 384 stations on the continents: this would be enough, were they not distributed in such an heterogeneous manner. The great majority is concentrated in Europe, the United States, Canada, Argentina, and British India. Hence detailed isanomals have not been drawn. Only the lines appear on the map which separate the positive from the negative anomalies; in addition, some regions with especially high anomalies have been specifically marked.

The principal features of the cartographic picture may be summarized as follows:

(1) Huge connected regions of the earth's surface show anomalies of the same sign. The distribution of positive and negative anomalies is therefore not to be ascribed to chance or accidental local conditions, but represents a significant climatological element.

[4] V. Conrad, M. Winkler, Beiträge zur Kenntnis der Schneedeckenverhältnisse in den besterreichischen Alpenländern. *Gerlands Beitrage Geoph. 34*, 1931, 473–511.
V. Conrad, Anomalien und Isanomalen der Sonnenscheindauer in den oester reichischen Alpen. Beihefte (Supplements) *Jahrb. Zentr. Anst. Meteor.*, Wien, 1938.

[5] If it were possible to make estimates of the yearly precipitation, e.g., for 5° squares, based on intensity of rain and the number of days with rain, the transition to the relative variability and its anomaly would be possible. E. Biel was so cautious and judicious as not to draw the isolines across the oceans.

(2) The greatest and most impressive accumulation of negative signs will be found in the immense areas of the temperate and high latitudes of Eurasia and North America. *The continental climate and its effects are regulators of the precipitation. The variability is less than normal. The variations of the general circulation are dampened by the influence of the continents.*

(3) A conspicuous exception is formed by the "semiarid region" [6] to the East of the Rocky Mountains. The remarkable conditions caused by the frequent chinook winds of this region overcompensate the continental influence on the anomaly of variability. This strip has *positive* anomalies. In the remaining vast region, which is at least partly covered with a dense net of stations, only negative signs are found, with the exception of the extreme coastal strips in eastern Asia and from California to Alaska.

(4) Extremely high positive anomalies exist on some continental coasts, especially those deficient in rain, where the weather is affected by ocean currents. This occurs, it seems, in California (California current) and in Chile-Peru (Peru-Humboldt current). The normal behavior of these cold currents causes the small yearly sums on the coast of South America, and the remarkable temperature conditions in California. The smallest deviation of these currents and an invasion by warm water between the stream and the coast involves relative abundant rains (El Niño problem). The high positive anomalies of North-east Brazil (Ceara) are not easy to explain. Here catastrophic droughts occur. These remarkable phenomena may also be caused by displacements of ocean currents. It would be a problem of oceanography to decide whether advances of the Benguela current or recessions of the Brazil current would be possible. The highest anomaly (+53 percent for Malden Island) has already been tentatively explained by displacements of ocean currents.

Exceedingly high positive anomalies over a very large region occur in Beluchistan, the Persian Gulf and the southern part of Arabia. This region also reaches into Africa to the sources of the Nile. On the one side we have the border regions of the monsoon; on the other, expecially rainless territories. Variations of the general circulation which are not dampened by continental influence are the cause of an abnormally high variability.

(5) Another characteristic feature may be emphasized: the influence of the tropic belt which lowers the variability in South America, Africa, and South Asia. The tropical climate is conservative—an *independent climate*. This postulate may be expressed in the more general form: *A climate shows the higher variability the more dependent it is.* This theorem holds perhaps for most *other* climatological elements. The anomalies of the variability are in this way perhaps a *measure* of the *independence* of a *climate*.

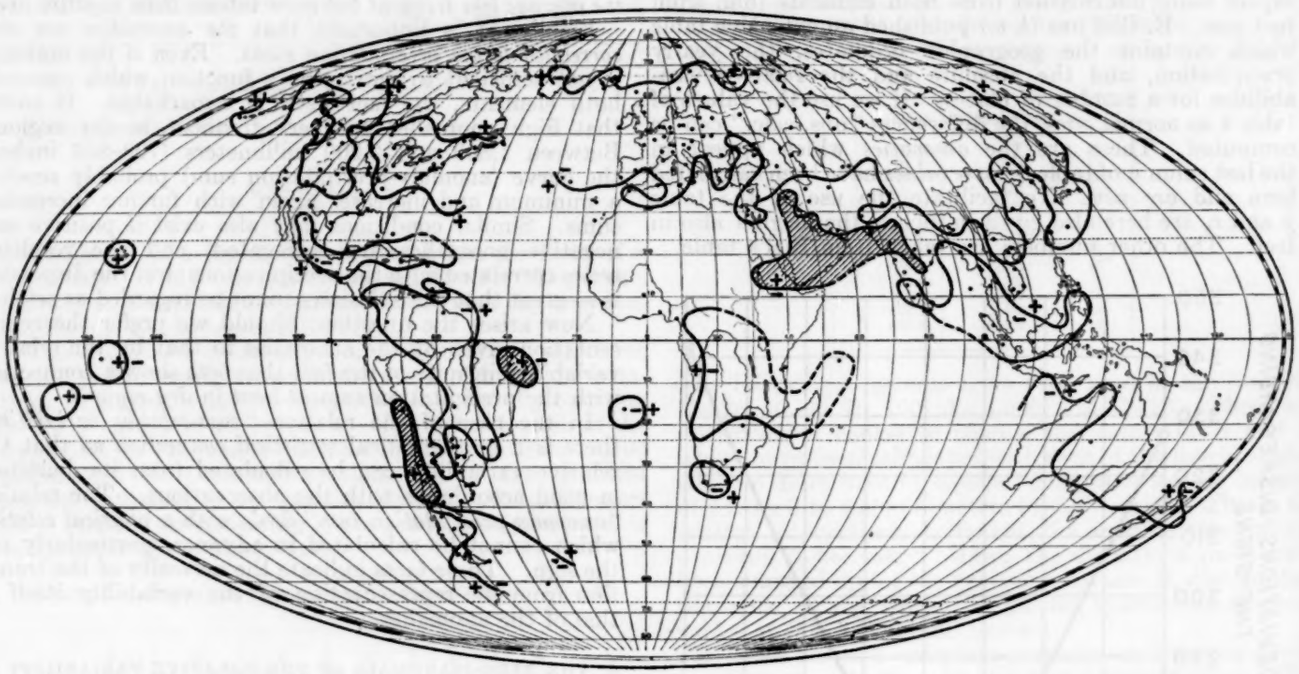

FIGURE 2.

The anomalies of precipitation variability therefore appear to reveal features which cast new light on the regime of precipitation and the regime of wind connected with it. The hydrologist who is interested in agricultural problems could apply this method of anomalies to smaller regions. In those of negative anomalies, for instance, it will be useful to cultivate plants of less adaptability. Water power economy may also make use of the knowledge which results from the representation of the anomalies of precipitation variability. The dimensions of a dam should depend on the anomaly of variability of rain.

The principal importance of the anomaly of variability is in dynamic climatology.

[6] See Goode's *School Atlas*, Number 42 (N. Y. 1923).

TABLE 5.—*Anomalies of the variability of yearly precipitation for 384 places*

$\bar{p}$=mean yearly sum of precipitation in millimeters and inches
v_a=absolute variability in millimeters and inches
v_r=relative variability in percent
Δ=anomaly deviation from the normal value in percent given by the equation,

$$v_r=\frac{3,600}{\bar{p}+60}+13^1$$

80°–70° N.

Station	Latitude	Longitude	Elevation		$\bar{p}$		v_a		v_r (percent)	Δ (percent)
			Meters	Feet	Millimeters	Inches	Millimeters	Inches		
1	2	3	4		5		6		7	8
	°	°								
Upernivik	72.8	56.1W.	19	62	226	8.9	80	3.15	35	+10
Gjesvar	71.1	25.4E.	7	23	740	29.1	135	5.32	18	0
70°–60° N.										
Nome	64.5	165.4 W.	7	23	442	17.4	97	3.82	22	+2
Tanana	65.2	152.1 W.	67	220	319	12.6	50	1.97	16	−7
Valdez	61.1	146.3 W.	3	10	1,327	52.3	207	8.15	16	+1
Eagle	64.8	141.2 W.	255	837	273	10.7	45	1.77	16	−7
Dawson	64.0	139.4 W.	321	1,053	383	15.1	62	2.40	16	−5
Godthaab	64.2	51.7 W.	9	30	578	22.8	158	6.72	27	+9
Jacobshavn	69.2	51.0 W.	13	43	235	9.3	55	2.17	23	−2
Ivigtut	61.2	48.2 W.	5	16	1,101	43.3	200	7.87	18	+2
Angmagsalik	65.6	37.6 W.	32	104	906	35.7	221	8.70	24	+7
Styrkisholm	65.1	22.8 W.	25	82	634	25.0	76	2.99	12	−7
Vestmanno	63.4	20.3 W.	13	43	1,365	53.7	147	5.79	11	−4
Grimsey	66.6	18.0 W.	22	72	218	8.6	113	4.45	52	+27
Berufjord	64.7	14.4 W.	18	59	1,195	47.0	194	7.64	16	0
Thorshavn	62.0	6.85 W.	26	85	1,432	56.4	200	7.87	14	−1
Bodö	67.3	12.4 E.	21	69	928	36.5	173	6.81	19	+2
Ostersund	63.2	14.6 E.	310	1,017	478	18.8	63	2.48	13	−6
Karesuanda	68.4	22.5 E.	333	1,093	309	12.2	49	1.93	16	−7
Haparanda	65.8	24.2 E.	9	30	507	20.0	60	2.36	12	−7
Helsinki	60.2	24.9 E.	12	39	661	26.0	80	3.15	12	−6
Archangelsk	64.6	40.6 E.	7	23	437	17.2	95	3.74	22	+2
Ust-Zylma	65.4	52.2 E.	25	82	421	16.6	52	2.05	12	−9
Obdorsk	66.5	66.6 E.	26	85	266	10.5	56	2.20	21	−3
Jakutsk	62.0	129.7 E.	98	322	190	7.5	32	1.26	17	−10
60°–50° N.										
St. Paul Island	57.2	170.2 W.	6	20	1,796	31.3	186	7.32	23	+6
Dutch Harbor	53.9	166.5 W.	4	13	1,592	62.7	185	7.28	12	−3
Kodiak	57.8	152.4 W.	5	16	1,550	61.0	227	8.94	15	0
Sitka	57.1	135.3 W.	27	89	2,258	88.9	278	10.95	12	−3
Juneau	58.3	134.4 W.	24	79	2,046	80.5	276	10.87	13	−2
Massett	54.0	132.2 W.	3	10	1,308	51.5	274	10.79	21	+6
Bella Coola	52.7	126.9 W.	46	151	1,153	45.4	216	8.50	19	+3
Barkerville	53.0	121.6 W.	1,275	4,183	947	37.3	133	5.24	14	−3
Kamloops	50.7	120.5 W.	364	1,194	253	10.0	39	1.53	15	−9
Calgary	51.0	114.0 W.	1,034	3,392	402	15.8	98	3.86	24	+3
Edmonton	53.6	113.5 W.	658	2,158	443	17.4	88	2.39	19	+7
Prince Albert	53.2	105.6 W.	437	1,434	398	15.7	95	3.74	24	+3
Qu'Appelle	50.5	103.8 W.	645	2,116	472	18.6	85	3.35	18	−2
Fort Hope	51.6	87.8 W.	336	1,102	405	15.9	75	2.95	19	−2
Valencia	51.9	10.2 W.	14	46	1,427	56.2	147	5.79	10	−5
Aberdeen	57.2	2.1 W.	14	46	753	29.6	61	2.40	8	−9
Greenwich	51.5	0 W.	46	151	604	23.8	66	2.60	11	−7
Utrecht-De Bilt	52.1	5.2 E.	3	10	751	29.6	87	3.42	12	−5
Gütersloh	51.9	8.4 E.	76	240	722	28.4	74	2.91	10	−8
Frankfurt a. M	50.1	8.7 E.	102	335	582	22.9	63	2.48	11	−7
Oslo	59.9	10.7 E.	25	82	567	22.3	76	2.99	13	−5
Copenhagen	55.7	12.6 E.	5	16	579	22.8	59	2.32	10	−8
Berlin	52.6	13.4 E.	35	115	561	22.1	66	2.60	12	−6
Breslau	51.1	17.0 E.	147	482	583	23.0	67	2.64	11	−7
Upsala	59.8	17.6 E.	24	79	535	21.2	67	2.64	13	−6
Königsberg	54.7	20.5 E.	3	10	687	27.0	81	3.19	12	−6
Warschau	52.2	21.0 E.	133	436	475	18.7	92	3.62	19	0
Wilna	54.7	25.3 E.	148	486	546	21.5	105	4.13	19	0
Leningrad	59.9	30.3 E.	5	16	519	20.4	60	2.36	12	−7
Kiew	50.4	30.5 E.	183	600	591	23.3	90	3.90	15	−3
Moskau	55.8	37.6 E.	164	538	600	23.6	85	3.35	14	−4
Nikolaewskoe	51.4	45.4 E.	193	633	363	14.3	62	2.44	17	−5
Kasan	55.8	49.1 E.	81	266	429	16.9	71	2.80	17	−4
Orenburg	51.8	55.1 E.	114	374	366	14.4	66	2.60	18	−4
Perm	58.0	56.3 E.	163	531	589	23.2	67	2.64	11	−7
Swerdlowsk	56.8	60.6 E.	281	922	426	16.8	53	2.09	12	−9
Barnaul	53.3	83.8 E.	158	518	485	19.1	73	2.87	15	−4
Tomsk	56.5	84.9 E.	122	400	534	21.0	77	3.03	15	−4
Irkutsk	52.3	104.3 E.	467	1,532	376	14.8	63	2.48	17	−4
Nertschinskij Sawod	51.3	119.6 E.	620	2,034	385	15.2	75	2.95	19	−2
Nikolajewsk on Amur	53.1	140.8 E.	33	108	471	18.5	83	3.27	18	−1

[1] If p is given in inches the equation is to be read $v_r=\frac{141.7}{p+2.36}+13$.

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TABLE 5.—*Anomalies of the variability of yearly precipitation for 384 places*—Continued

50°–40° N.

Station	Latitude	Longitude	Elevation		$\bar{p}$		v_a		v_r (percent)	Δ (percent)
			Meters	Feet	Millimeters	Inches	Millimeters	Inches		
1	2	3	4		5		6		7	8
	°	°								
Victoria	48.4	123.3 W.	70	230	786	30.9	153	6.02	20	+3
Portland	45.5	122.7 W.	47	154	1,051	41.4	135	5.32	13	−3
Red Bluff	40.2	122.2 W.	101	331	621	24.4	131	5.16	21	+2
Spokane	47.7	117.4 W.	588	1,929	420	16.5	67	2.64	16	−5
Helena	46.6	112.1 W.	1,254	4,114	340	13.4	70	2.76	21	−1
Salt Lake City	40.8	111.9 W.	1,330	4,364	407	16.0	57	2.24	14	−7
Cheyenne	41.1	104.8 W.	1,857	6,092	385	15.2	65	2.56	17	−4
North Platte	41.1	100.8 W.	860	2,822	479	18.9	104	4.09	22	+3
Bismarck	46.8	100.6 W.	511	1,676	410	16.1	61	2.40	15	−6
Winnipeg	49.9	97.1 W.	232	761	513	20.2	74	2.91	14	−5
Omaha	41.3	95.9 W.	337	1,106	713	28.1	151	5.94	21	+3
Oregon, Mo	40.0	95.2 W.	320	1,050	888	35.0	168	6.61	19	+2
St. Paul	45.0	93.0 W.	255	837	701	27.6	118	4.65	17	−1
Duluth	46.8	92.1 W.	346	1,135	701	27.6	104	4.09	15	−3
Peoria	40.7	89.6 W.	186	610	888	35.0	117	4.61	13	−4
Chicago	41.9	87.6 W.	251	823	822	32.4	121	4.76	15	−2
Marquette	46.6	87.4 W.	224	735	828	32.6	92	3.62	11	−6
Detroit	42.3	83.0 W.	223	732	795	31.3	87	3.43	11	−6
Toronto	43.7	79.4 W.	116	381	791	31.1	62	2.44	8	−9
Abitibi	48.7	79.4 W.	259	850	666	26.2	121	4.76	18	0
New York	40.7	74.0 W.	96	315	1,105	43.5	118	4.65	11	−5
Albany	42.6	73.8 W.	30	98	875	34.4	104	4.09	12	−5
Montreal	45.5	73.6 W.	57	187	1,033	40.7	90	3.54	9	−7
Burlington	44.5	73.2 W.	123	404	808	31.8	116	4.57	14	−3
New Haven	41.3	72.9 W.	32	105	1,149	45.2	129	5.08	11	−5
Chicoutimi	48.4	71.1 W.	46	151	664	26.1	117	4.61	18	0
Boston	42.4	71.1 W.	38	125	1,006	39.6	106	4.17	11	−5
Father Point	48.5	68.2 W.	6	20	852	33.5	104	4.09	12	−5
Eastport	44.9	67.0 W.	23	75	1,010	39.8	158	6.26	16	0
Cape Magdalene	49.3	65.3 W.	28	92	783	30.8	115	4.53	15	−2
SW Point, Anticosti	49.4	63.7 W.	9	30	788	31.0	133	5.24	17	0
Charlottetown	46.2	63.2 W.	14	46	1,030	40.6	108	4.25	10	−6
Sable Island	44.0	60.1 W.	8	26	1,317	51.9	129	5.08	10	−5
St. Johns	47.6	52.7 W.	38	125	1,399	55.1	154	6.06	11	−4
Madrid	40.4	3.7 W.	655	2,148	436	17.2	78	3.07	18	−3
Bilbao	43.3	2.9 W.	17	56	1,125	44.3	182	7.17	16	0
Nantes	47.2	1.6 W.	37	121	786	30.9	123	4.84	16	−1
Toulouse	43.6	1.4 E.	194	636	679	26.7	88	3.46	13	−5
Paris (Parc S. Maur)	48.8	2.5 E.	50	164	571	22.5	60	2.36	11	−7
Lyon	45.7	4.8 E.	299	981	756	29.8	105	4.13	14	−3
Marseille	43.3	5.4 E.	75	246	579	22.8	124	4.88	21	+3
Trier	49.8	6.6 E.	(?)	(?)	687	27.0	66	2.60	10	−8
Zurich	47.4	8.6 E.	477	1,565	1,077	42.4	130	5.12	12	−4
Sassari	40.7	8.6 E.	224	735	599	23.6	92	3.62	15	−3
Milan	45.5	9.2 E.	147	482	1,053	41.4	151	5.94	14	−2
Säntis	47.2	9.3 E.	2,500	8,202	2,715	106.9	413	16.26	15	+1
Rome	41.9	12.5 E.	63	207	908	35.7	130	5.12	14	−3
Sonnblick	47.0	13.0 E.	3,107	10,194	1,650	65.0	178	7.01	11	−4
Obir	46.5	14.5 E.	2,044	6,706	1,527	60.1	186	7.32	12	−3
Vienna	48.2	16.4 E.	203	666	679	26.7	82	3.23	12	−6
Hvar (Lesina)	43.2	16.4 E.	20	66	800	31.5	139	5.47	17	0
Belgrade	44.8	20.4 E.	138	453	619	24.4	110	4.33	18	−1
Krynica	49.4	21.0 E.	586	1,923	834	32.8	94	3.70	11	−6
Debreczin	47.5	21.8 E.	130	427	619	24.4	98	3.86	16	−3
Sofia	42.7	23.3 E.	(?)	(?)	637	25.1	115	4.53	18	0
Lwow	49.8	24.0 E.	298	978	684	26.9	95	3.74	14	−4
Hermannstadt	45.8	24.3 E.	419	1,375	694	27.3	89	3.50	13	−5
Bucharest	44.4	26.1 E.	82	269	590	23.6	89	3.50	15	−3
Böjükdere	41.2	29.0 E.	(?)	(?)	843	33.2	209	8.23	25	+8
Sulina	45.2	29.7 E.	2	(?)	373	14.7	76	2.99	20	−1
Odessa	46.5	30.7 E.	65	213	392	15.4	86	2.39	22	+1
Noworossijsk	44.7	37.8 E.	37	121	644	25.4	141	5.55	22	+3
Tiflis	41.7	44.8 E.	404	1,325	502	19.8	73	2.87	15	−4
Astrachan	46.4	48.0 E.	14	46	168	6.6	47	1.85	28	−1
Kasalinsk	45.3	62.1 E.	(?)	(?)	125	4.9	25	.98	20	−11
Taschkent	41.3	69.3 E.	478	1,568	359	14.1	61	2.40	17	−5
Wjernyi (Alma ata)	43.3	76.9 E.	775	2,542	570	22.4	107	4.21	19	+1
Mukden	41.8	123.4 E.	44	144	631	24.8	125	4.92	20	+2
Joshin	40.7	129.2 E.	4	------	706	27.8	85	3.35	12	−6
Ochiai	47.3	142.7 E.	7	------	888	35.0	102	4.02	12	−5
Nemuro	43.3	145.6 E.	27	------	960	37.8	158	6.22	16	0
40°–30° N.										
S. Francisco	37.8	122.4 W.	47	154	544	21.4	123	4.84	23	+4
Sacramento	38.6	121.4 W.	21	69	461	18.2	104	4.09	23	+4
S. Luis Obispo	35.3	120.6 W.	61	200	551	21.7	166	6.54	30	+1
S. Diego	32.7	117.2 W.	27	89	252	9.9	77	3.03	31	+7
Yuma	32.8	114.6 W.	43	141	86	2.4	38	1.50	44	+6
Modena	37.8	113.9 W.	1,671	5,482	289	11.4	61	2.40	21	−2
Phoenix	33.5	112.0 W.	388	1,273	202	8.0	63	2.48	31	+5
El Paso	31.8	106.5 W.	1,147	3,763	238	9.4	75	2.95	32	+7
Santa Fe	35.7	106.0 W.	2,139	7,018	366	14.4	72	2.83	20	−4
Denver	39.8	105.0 W.	1,614	5,295	361	14.2	76	2.99	21	−1
Abilene	32.4	99.7 W.	530	1,739	612	24.1	140	5.51	23	+5
Little Rock	34.8	92.3 W.	109	358	1,232	48.5	198	7.80	16	0
St. Louis	38.6	90.2 W.	173	568	955	37.6	117	4.61	12	−4
Mobile	30.7	88.0 W.	17	------	1,589	62.6	251	9.88	16	+1

TABLE 5.—*Anomalies of the variability of yearly precipitation for 384 places*—Continued

40°–30° N.

Station	Latitude	Longitude	Elevation		$\bar{p}$		v_a		v_r (percent)	Δ (percent)
			Meters	Feet	Millimeters	Inches	Millimeters	Inches		
1	2	3	4		5		6		7	8
	°	°								
Nashville	36.2	86.8 W.	167	548	1,182	46.6	132	5.20	11	−5
Cincinnati	39.1	84.5 W.	192	630	947	37.3	137	5.39	14	−3
Portsmouth, Ohio	38.7	82.9 W.	161	528	1,086	42.7	109	4.29	10	−6
Charleston	32.8	79.9 W.	15	49	1,140	44.9	189	7.44	17	+1
Washington	38.9	77.0 W.	34	112	1,078	42.4	124	4.88	12	−4
Hatteras	35.2	75.7 W.	3	10	1,295	51.0	251	9.88	19	+4
Philadelphia	40.0	75.2 W.	36	118	1,048	41.2	122	4.80	12	−4
Bermudas	32.3	64.8 W.	45	148	1,481	58.3	172	6.77	12	−3
Horta	38.5	28.6 W.	64	210	1,091	43.0	169	6.65	15	−1
Ponta Delgada	37.7	25.7 W.	38	125	720	28.3	111	4.37	15	−3
Funchal	32.6	16.9 W.	25	82	697	27.4	165	6.50	24	+6
Lissabon	38.7	9.1 W.	95	312	749	29.5	120	4.72	16	−2
Cap Spartel	35.8	5.9 W.	56	184	771	30.3	126	4.96	16	−1
Gibraltar	36.1	5.3 W.	16	52	919	36.2	185	7.28	20	+3
Cartagena	37.6	0.9 W.	13	43	359	14.1	99	3.90	28	+6
Alicante	38.4	0.4 W.	26	85	394	15.5	121	4.76	31	+10
Palma	39.6	2.7 E.	(?)	(?)	500	19.7	83	3.27	17	−2
Bouzareah	36.8	3.0 E.	344	1,129	697	27.4	149	5.87	21	+3
Tunis	36.8	10.2 E.	21	69	419	16.5	58	2.28	14	−7
Catania	37.5	15.0 E.	65	213	625	24.6	173	6.81	28	+10
Corfu	39.5	19.8 E.	26	85	1,216	47.8	223	8.78	18	+2
Athens	38.0	23.7 E.	107	351	394	15.5	61	2.40	15	−6
Alexandria	31.2	29.9 E.	32	105	203	8.0	43	1.69	21	−5
Abbassia	30.1	31.3 E.	33	108	34	1.3	17	.67	50	−1
Jerusalem	31.8	35.2 E.	746	2,448	645	25.4	151	5.94	23	+5
Adana	36.9	35.3 E.	(?)	(?)	640	25.2	114	4.49	18	0
Beirut	33.9	35.5 E.	34	112	915	36.0	135	5.28	15	−2
Bagdad	33.3	44.4 E.	38	125	180	7.1	85	3.35	47	+19
Basra	30.5	47.8 E.	7	23	163	6.4	63	2.48	39	+10
Teheran	35.7	51.4 E.	1,221	4,006	242	9.5	52	2.05	21	−4
Isfahan	32.7	51.7 E.	1,774	5,820	114	4.5	41	1.61	36	+7
Meschhed	36.3	59.6 E.	947	3,117	237	9.3	65	2.56	27	+2
Quetta	30.2	67.0 E.	1,678	5,505	243	9.6	68	2.68	28	+3
Peschawar	34.0	71.6 E.	339	1,125	346	13.6	91	3.58	26	+4
Lahore	31.6	74.4 E.	214	702	503	19.8	149	5.87	30	+11
Simla	31.1	77.2 E.	2,206	7,238	1,617	63.7	259	10.20	16	+1
Leh	34.2	77.7 E.	3,508	11,509	83	3.3	27	1.06	33	−6
I-tch'ang	30.7	111.3 E.	518	1,699	1,095	43.1	157	6.18	14	−2
Han-k'eou	30.6	114.3 E.	36	118	1,259	49.6	243	9.57	19	+4
Tien-tsin	39.2	117.2 E.	5	16	509	20.0	121	4.76	24	+5
Ou-hou	31.3	118.4 E.	15	49	1,219	48.0	245	9.61	20	+4
Tchen-kiang	32.2	119.4 E.	12	39	1,040	40.9	223	8.78	21	+5
Heou-k'i	38.1	120.6 E.	90	295	463	18.2	116	4.57	25	+5
Tche-fou	37.6	121.4 E.	3	10	620	24.4	126	4.96	20	+2
Zi-ka-wei	31.2	121.4 E.	7	23	1,152	45.4	137	5.39	12	−4
Chemulpo	37.3	126.5 E.	68	223	950	37.4	175	6.89	18	+2
Nagasaki	32.7	129.9 E.	133	436	1,954	77.0	274	10.79	14	−1
Kioto	35.0	135.7 E.	49	161	1,573	61.9	209	8.23	13	−2
Tokyo	35.7	139.8 E.	21	69	1,540	60.6	206	8.11	13	−2
Miyako	39.6	141.9 E.	30	98	4131	55.6	215	8.46	15	0

30°–20° N.

Honolulu	21.3	157.9 W.	12	39	798	31.4	230	9.06	29	+12
Mazatlan	23.2	106.4 W.	4	13	723	28.5	215	8.45	30	+12
Chihuahua	28.6	106.1 W.	1,423	4,669	381	15.0	70	2.76	18	−3
Leon	21.1	101.7 W.	1,809	5,936	641	25.2	131	5.16	20	+2
Monterrey	25.7	100.3 W.	528	1,732	496	19.5	190	7.48	38	+19
Corpus Christi	27.8	97.4 W.	6	20	638	25.1	151	5.94	24	+6
Galveston	29.3	94.8 W.	16	52	1,135	44.7	247	9.72	22	+6
New Orleans	30.0	90.1 W.	16	52	1,444	56.9	242	9.53	17	+2
Progreso	21.3	89.7 W.	14	46	429	16.9	60	2.36	14	−7
Merida	21.0	89.6 W.	22	72	892	35.1	173	6.81	19	+2
Habana	23.1	82.4 W.	24	79	1,211	47.7	171	6.73	14	−2
Key West	24.6	81.8 W.	7	23	966	38.0	186	7.32	19	+3
Nassau	25.1	77.4 W.	15	49	1,231	48.5	214	8.43	17	+1
La Laguna	28.5	16.3 W.	2	7	594	23.4	176	6.93	30	+12
Heluan	29.9	31.3 E.	116	381	34	1.3	17	.67	50	−1
Bushire	29.0	49.8 E.	4	13	272	10.7	103	4.06	38	+15
Jask	25.8	57.8 E.	4	13	115	4.5	43	1.69	37	+4
Maskat	23.6	58.6 E.	6	20	106	4.2	56	2.20	53	+19
Kelat	29.0	66.5 E.	2,022	6,634	188	7.4	49	1.93	26	−1
Karachi	24.8	67.1 E.	4	13	188	7.4	109	4.29	58	+31
Haiderabad	25.4	68.4 E.	29	95	191	7.5	106	4.17	55	+28
Ahmadabad	23.0	72.6 E.	50	164	729	28.7	228	8.98	31	+13
Jaipur	26.9	75.9 E.	436	1,430	612	24.1	184	7.24	30	+12
Nagpur	21.2	79.2 E.	310	1,017	1,243	48.9	207	8.15	17	+1
Allahabad	25.5	81.9 E.	94	308	1,011	39.8	214	8.43	21	+5
Patna	20.7	83.2 E.	56	184	1,236	48.6	279	10.98	23	+7
Calcutta (Alipore)	22.5	88.4 E.	6	20	1,598	62.9	225	8.86	14	−1
Cherrapunji	25.2	91.8 E.	1,314	4,311	10,914	429.2	1,677	66.02	15	+2
Gauhati	26.2	91.8 E.	60	197	1,628	64.1	181	7.13	11	−4
Shillong	25.6	91.9 E.	1,501	4,924	2,057	81.0	277	10.91	13	−2
Akyab	20.1	93.0 E.	6	20	5,266	207.3	594	23.24	11	−3
Mandalay	22.0	96.1 E.	76	249	891	35.1	167	6.57	19	+2
Teng-yue	24.8	98.2 E.	1,633	5,358	1,479	58.2	230	9.06	16	+1
Yun-nan-fou	25.0	102.7 E.	1,893	6,211	1,040	40.9	164	6.46	16	0
Mong-tse	23.4	103.4 E.	1,305	4,281	925	36.4	134	5.28	14	−3
Laokay	22.5	103.9 E.	93	305	1,807	71.0	259	10.20	14	−1

TABLE 5.—*Anomalies of the variability of yearly precipitation for 384 places*—Continued

30°–20° N.

Station	Latitude	Longitude	Elevation		$\bar{p}$		v_a		v_r (percent)	Δ (percent)
			Meters	Feet	Millimeters	Inches	Millimeters	Inches		
1	2	3	4		5		6		7	8
	°	°								
Tch'ong-k'ing	29.6	106.5 E.	230	755	1,103	43.4	166	6.54	15	−1
Phu-lien	20.8	106.6 E.	116	381	1,641	64.6	201	7.91	12	−3
Moneay	21.5	107.8 E.	9	30	2,686	105.8	181	7.13	7	−8
Kweilin	25.3	110.4 E.	(?)	(?)	1,986	78.2	273	10.75	14	−1
Ou-tcheou	23.5	111.3 E.	2	7	1,299	51.1	165	6.50	13	−2
Tch'ang-cha	28.2	112.8 E.	60	197	1,412	55.6	304	11.97	22	+7
Hongkong	22.3	114.2 E.	33	108	2,141	84.3	376	14.80	18	+3
Amoy	24.4	118.1 E.	4	13	1,183	46.6	224	8.82	19	+3
Fou-tcheou	26.0	119.4 E.	20	66	1,435	56.5	364	14.33	25	+10
Taihoku	25.0	121.5 E.	9	30	2,114	83.2	247	9.72	12	−3
Naha	26.2	127.7 E.	11	36	2,134	84.0	306	12.05	14	−1

20°–10° N.

Mexico City	19.4	99.1 W.	2,259	7,084	577	22.7	82	3.23	14	−4
Puebla	19.0	98.2 W.	2,150	7,054	845	33.3	127	5.00	15	−2
Oaxaca	16.1	96.7 W.	1,563	5,128	684	26.9	150	5.91	22	+4
Salina Cruz	16.2	95.2 W.	56	184	932	36.7	243	9.57	26	+9
Chimax near Coban	15.6	90.4 W.	(?)	(?)	2,438	96.0	245	9.65	10	−5
Port-au-Prince	18.6	72.4 W.	37	121	1,380	54.3	192	7.56	14	−1
Caracas	10.5	67.0 W.	1,042	3,419	806	31.7	102	4.02	13	−4
S. Juan	18.5	66.1 W.	25	82	1,536	60.5	177	6.97	12	−3
Christiansted	17.8	64.7 W.	7	23	1,187	46.7	244	9.61	21	+5
Richmond Hill	12.1	61.8 W.	155	509	1,932	76.1	235	9.25	12	−3
Trinidad	10.7	61.5 W.	20	66	1,584	62.4	246	9.69	16	+1
Barbados	13.1	59.6 W.	55	180	1,343	52.9	264	10.39	20	+5
Bathurst	13.4	16.6 W.	2	7	1,209	47.6	274	10.79	23	+8
St. Louis	16.0	16.5 W.	5	16	360	14.2	106	4.17	29	+7
Gambaga	10.5	0.4 W.	107	351	1,157	45.6	198	7.80	17	+1
Chartum	15.6	32.6 E.	390	1,280	145	5.7	62	2.44	43	+13
Aden	12.8	45.0 E.	29	95	47	1.9	31	1.22	66	+19
Bombay	18.9	72.9 E.	11	36	1,774	69.8	345	13.58	19	+4
Belgaum	15.9	74.6 E.	781	2,562	1,300	51.2	202	7.95	16	+1
Mangalore	12.9	74.9 E.	22	72	3,188	125.5	388	15.28	12	−2
Kodaikanal	10.2	77.5 E.	2,345	7,693	1,579	62.2	171	6.73	11	−4
Bangalore	13.0	77.6 E.	921	3,021	881	34.7	151	5.94	17	0
Madras	13.1	80.2 E.	7	23	1,293	50.9	269	10.59	21	+6
Masulipatam	16.2	81.2 E.	5	16	1,044	41.1	269	10.59	26	+10
Waltair (Vizagapatam)	17.7	83.3 E.	12	39	1,000	39.4	239	9.41	24	+8
Port Blair	11.7	92.8 E.	18	59	2,931	115.4	308	12.13	11	−3
Rangun	16.8	96.2 E.	5	16	2,528	99.5	176	6.93	7	−7
Moulmein	16.5	96.6 E.	23	75	4,857	191.2	432	16.94	9	−5
Mergui	12.4	98.6 E.	18	59	4,232	166.6	397	15.63	9	−5
Pnom Penh	11.5	105.0 E.	13	43	1,417	55.8	235	9.25	17	+2
Saigon	10.8	106.7 E.	11	36	1,966	77.4	293	11.54	15	0
Quangtri	16.7	107.2 E.	8	26	2,514	99.0	454	17.73	18	+4
Nhatrang	12.2	109.2 E.	4	13	1,372	54.0	406	15.77	30	+15
Manila	14.6	120.9 E.	16	52	2,022	79.6	354	13.94	18	+3
Aparri	18.4	121.6 E.	5	16	2,227	87.7	484	18.91	22	+7
Iloilo	10.7	122.6 E.	7	23	2,214	87.2	210	8.27	9	−6
Legaspi	13.2	123.8 E.	6	20	3,225	127.0	698	27.20	22	+8

10° N.–0°

S. José	9.9	84.1 W.	1,135	3,723	1,799	70.8	368	14.41	20	+5
Colon	9.4	79.4 W.	11	36	3,282	129.2	371	14.61	11	−3
Bogotá	4.6	74.1 W.	2,651	8,697	1,024	40.3	136	5.35	13	−3
Georgetown	6.8	58.2 W.	2	7	2,252	88.7	259	10.20	12	−3
Freetown	8.5	13.2 W.	57	187	3,925	154.5	603	23.63	15	+1
Accra	5.2	0.2 W.	18	59	692	27.2	172	6.77	25	+7
Lagos	6.4	3.4 E.	2	7	1,819	71.6	316	12.44	17	+2
Calabar	5.0	8.3 E.	12	39	3,130	123.2	461	18.15	15	+1
Debundscha	4.1	9.0 E.	5	16	9,877	388.9	1,912	75.28	19	+6
Duala	4.0	9.7 E.	12	39	3,974	156.5	475	18.70	12	−2
Entebbe	0.1	32.5 E.	1,173	3,849	1,474	58.0	134	5.28	9	−6
Cochin	9.9	76.3 E.	3	10	2,886	113.6	367	14.45	13	−1
Colombo	6.9	79.8 E.	12	39	2,033	80.0	326	12.83	16	+1
Nuwara Eliha	7.0	80.8 E.	1,887	6,191	2,337	92.0	258	10.16	11	−4
Trincomalee	8.6	81.2 E.	30	98	1,565	61.6	267	10.51	17	+2
Kuta-Raja	5.5	95.3 E.	7	23	1,639	64.5	203	7.99	12	−3
Medan	3.6	98.7 E.	20	66	2,044	80.5	246	9.68	12	−3
Sandakan	5.8	118.2 E.	32	105	3,041	119.7	549	21.61	18	+4
Menado	1.5	124.8 E.	4	13	2,635	103.7	452	17.80	17	+3

0°–10° S.

Malden Island	4.0	155.0 W.	6	20	727	28.6	514	20.24	71	+53
Quixeramobim	5.3	39.2 W.	207	679	637	25.1	267	10.51	42	+24
Fortaleza	3.7	38.5 W.	20	66	1,423	55.1	484	19.06	34	+19
Recife	8.1	34.9 W.	30	98	1,388	54.6	452	17.80	33	+18
Sansibar	6.2	39.2 E.	17	56	1,529	60.2	300	11.81	20	+5
Dar-es-Salaam	6.5	39.3 E.	76	249	1,075	42.3	233	9.17	22	+6
Port Victoria	4.6	55.4 E.	(?)	(?)	2,400	94.5	336	13.23	14	−1
Padang	0.9	100.4 E.	1	3	4,442	174.9	339	13.35	8	−6
Batavia	6.2	106.8 E.	7	23	1,824	71.8	284	11.18	16	+1

TABLE 5.—*Anomalies of the variability of yearly precipitation for 384 places*—Continued

0°-10° S.

Station	Latitude	Longitude	Elevation		$\bar{p}$		σ_p		σ_p (percent)	Δ (percent)
			Meters	Feet	Millimeters	Inches	Millimeters	Inches		
1	2	3	4		5		6		7	8
	°	°								
Pontianak	0.0	109.3 E.	3	10	3,202	126.1	379	14.92	12	−2
Pasuruan	7.6	112.9 E.	5	16	1,299	51.1	271	10.67	21	+5
Kajoemas	7.9	114.2 E.	930	3,051	2,524	99.4	354	13.94	14	0
Amboina	3.7	128.2 E.	1	3	3,375	132.9	867	34.13	26	+12
Monokwari	0.9	134.3 E.	20	66	2,478	97.5	513	20.20	21	+6
Port Moresby	9.5	147.2 E.	38	125	1,037	40.8	211	8.31	20	+4

10°-20° S.

Apia	13.8	171.8 W.	2	7	2,728	107.4	526	20.71	19	+5
Arequipa	16.4	71.6 W.	2,453	8,048	106	4.2	57	2.24	54	+20
Cuyaba	15.6	56.1 W.	165	541	1,388	54.6	178	7.01	13	−2
St. Helena	16.0	5.7 W.	604	1,971	1,019	40.1	114	4.49	11	−5
Salisbury	17.8	31.1 E.	1,481	1,578	811	31.9	127	5.00	16	−1
Antananarivo	18.9	47.5 E.	1,402	4,600	1,369	53.9	196	7.72	14	−1
Kupang	10.2	123.6 E.	15	49	1,486	58.5	294	11.57	20	+5
Darwin	12.5	130.8 E.	30	98	1,554	61.2	220	8.66	14	−1

20°-30° S.

La Serena	29.9	71.3 W.	35	115	140	5.5	82	3.23	59	+20
Catamarca	28.4	65.8 W.	510	1,673	350	13.8	71	2.80	20	−2
Salta	24.8	65.5 W.	1,178	3,865	722	28.4	133	5.24	18	0
Tucuman	26.8	65.2 W.	447	1,467	975	38.4	169	6.65	17	+1
Goya	29.2	59.2 W.	26	85	1,036	40.8	274	10.79	26	+10
Corrientes	27.4	58.8 W.	54	177	1,197	47.1	224	8.82	19	+3
Mision Inglesa	23.4	58.4 W.	(?)	(?)	1,205	47.4	266	10.47	22	+6
Villa Rica	25.1	58.1 W.	(?)	(?)	1,490	58.7	280	11.02	19	+4
Asuncion	25.3	57.7 W.	93	305	1,315	51.8	238	9.37	18	+3
Posadas	27.4	55.8 W.	138	453	1,507	59.3	315	12.40	21	+6
Curityba	25.4	49.3 W.	908	2,979	1,397	55.0	197	7.76	14	−1
Alto da Serra	23.8	46.6 W.	800	2,625	3,575	140.8	398	15.67	11	−3
Rio de Janeiro	22.9	43.2 W.	61	200	1,101	43.3	202	7.95	18	+2
Swakopmund	22.7	14.5 E.	8	26	16	0.6	9	0.35	54	−6
Windhuk	22.6	17.1 E.	1,665	5,462	389	15.3	121	4.76	31	+10
Bethanien	26.5	17.2 E.	935	3,067	105	4.1	42	1.65	40	+5
O'Okiep	29.6	17.9 E.	926	3,038	169	6.7	43	1.69	25	−4
Kimberley	28.7	24.8 E.	1,203	3,947	412	16.2	97	3.82	24	+3
Johannesburg	26.2	28.1 E.	1,807	5,928	844	33.2	146	5.75	17	0
Bulawayo	20.2	28.7 E.	1,354	4,442	600	23.6	137	5.39	23	+5
Durban	29.8	31.0 E.	15	49	1,082	42.6	195	7.68	18	+2
Alice Springs	23.6	133.6 E.	587	1,926	267	10.5	91	3.58	34	+10
Brisbane	27.5	153.0 E.	38	125	1,088	42.8	273	10.75	25	+9

30°-40° S.

Valdivia	38.8	73.2 W.	15	49	2,664	104.9	364	14.33	14	0
Junin de los Andes	39.2	71.0 W.	(?)	(?)	532	20.9	210	8.27	39	+20

TABLE 5.—*Anomalies of the variability of yearly precipitation for 384 places*—Continued

30°-40° S.

Station	Latitude	Longitude	Elevation		$\bar{p}$		σ_p		σ_p (percent)	Δ (percent)
			Meters	Feet	Millimeters	Inches	Millimeters	Inches		
1	2	3	4		5		6		7	8
	°	°								
Santiago	33.4	70.7 W.	519	1,703	373	14.7	156	6.14	42	+20
Mendoza	32.9	68.8 W.	755	2,477	198	7.8	63	2.48	32	+6
S. Juan	31.5	68.7 W.	664	2,178	75	3.0	36	1.42	48	+8
Neuqueen	39.0	68.0 W.	271	889	131	5.2	46	1.81	35	+4
Cordoba	31.4	64.2 W.	423	1,388	697	27.4	119	4.68	17	−1
General Acha	37.1	64.1 W.	218	715	472	18.6	128	5.04	27	+8
Bahia Blanca	38.7	62.2 W.	25	82	550	21.7	160	6.30	29	+10
Buenos Aires	34.6	58.4 W.	25	82	988	38.9	225	8.86	23	+7
Concordia	31.4	58.0 W.	24	79	1,017	39.8	205	8.07	20	+4
Mar del Plata	38.0	57.1 W.	4	13	723	28.5	147	5.79	20	+2
Ajo-General Lavalle	36.5	56.8 W.	15	49	925	36.4	205	8.07	22	+5
Montevideo	34.9	56.2 W.	29	95	986	38.8	262	10.31	27	+11
Kapstadt	33.9	18.5 E.	12	39	663	26.1	96	3.78	14	−4
Port Elizabeth	34.0	25.6 E.	55	180	562	22.1	87	3.43	15	−3
Alfwal (N)	30.7	26.7 E.	1,327	4,354	518	20.4	113	4.45	22	+3
Adelaide	34.9	138.6 E.	43	141	523	20.6	102	4.02	20	+1
Sydney	33.9	151.2 E.	42	138	1,175	46.3	219	8.62	19	+3
Auckland	36.8	174.8 E.	38	125	1,099	43.3	181	7.13	16	0

40°-50° S.

Punta Galera	40.0	73.7 W.	40	131	2,220	87.4	380	14.96	17	+2
Diez-y-seis de Octubre	42.2	71.1 W.	557	1,827	431	17.0	114	4.49	26	+5
Sarmiento	45.5	69.0 W.	274	899	135	5.3	49	1.93	36	+5
Puerto Madryn	42.8	64.9 W.	14	46	163	6.4	47	1.85	29	0
Hokitika	42.7	170.8 E.	3	10	2,896	114.0	277	10.91	10	+4
Christchurch	43.5	172.6 E.	8	26	653	25.7	105	4.13	16	−2
Wellington	41.3	174.8 E.	3	10	1,186	46.7	202	7.95	17	+1

50°-60° S.

Islote de los Evangelistad	52.4	75.1 W.	55	180	3,075	121.1	287	11.30	9	+6
Punta Arenas	53.2	70.9 W.	28	92	388	15.3	68	2.68	17	−4
Santa Cruz	50.2	68.4 W.	12	39	150	5.9	31	1.22	21	−9
Año Nuevo	54.6	64.2 W.	53	174	610	24.0	47	1.85	8	−10
Stanley	51.7	57.8 W.	2	7	685	27.0	68	2.68	10	−8
South-Georgia (Grytviken)	54.2	36.6 W.	4	103	1,301	51.6	176	6.93	14	−1

60°-70° S.

South-Orkneys (Laurie-Isld.)	60.7	44.6 W.	7	23	403	15.9	57	2.24	14	−7

METEOROLOGICAL AND CLIMATOLOGICAL DATA FOR JANUARY 1941

[Climate and Crop Weather Division, J. B. KINCER in charge]

AEROLOGICAL OBSERVATIONS

By EARL C. THOM

Mean surface temperatures for January were above normal over most of the country (chart I). Temperatures were slightly below normal, however, over New England, over the extreme eastern Great Lakes States, and over small areas along the Atlantic coast, and the eastern Gulf coast. The area having the largest positive departure for the month was in eastern Montana where mean temperatures slightly more than 8° F. above normal were recorded. This is the second successive month when temperatures were generally above normal.

At the 1,500 m.-level the directions of the 5 a. m. resultant winds for the month were to the north of directions of the corresponding 5 a. m. normals at most stations over the eastern half of the country, while the direction of these winds were generally south of normal to the westward. There were many stations in January at which less than 10 of the 5 a. m. pilot-balloon observations reached the 3,000 m.-level. With only one exception the 5 a. m. resultant winds for the month at 3,000 meters were from directions to the north of normal at all stations for which this comparison could be made over the eastern two-thirds of the country while these winds were from directions to the south of normal at the corresponding stations to the westward. At only seven of the pilot-balloon stations for which 5 a. m. normals are available did 10 or more of the 5 p. m. observations reach 5,000 meters. For this reason no comparison can be made between the directions of 5 p. m. resultant winds and the corresponding 5 a. m. normals for this level.

The 5 a. m. resultant veolcities for the month were below normal at the 1,500-meter level over about three-fourths of the country. Over Brownsville at this level and over the north-western and west-central States, however, the resultant velocities were above normal. The largest negative departure at this level, −3.2 m. p. s.,

occurred at Sault Ste. Marie, while the largest positive value +4.6 m. p. s., was noted at Seattle. At 3,000 meters five scattered stations had resultant velocities above normal, while velocities were below normal at all other stations, for which these values could be compared. Large negative departures at this level occurred over the Rocky Mountain Region, Cheyenne showing a resultant velocity of 4.6 m. p. s. below normal.

The directions of the 5 p. m. resultant winds were south of the corresponding 5 a. m. winds at 1,500 meters over somewhat more than one-half of the country, and were north of the morning winds over the remainder. At 3,000 meters the direction of the afternoon resultant winds were north of the direction of the corresponding morning winds over two irregular areas, one in the Rocky Mountain plateau region, the other in the Gulf States while the opposite turning during the day occurred at all other stations for which this comparison could be made. At 1,500 meters there were no well-defined tendencies, indicating areas of increase or decrease in the resultant velocity from 5 a. m. to 5 p. m. during the month. At 3,000 meters, however, only four stations, all situated in the north-central part of the country, had resultant velocities at 5 p. m. lower than those at 5 a. m., while an increase in velocity during the day was noted at all other stations at which these values were compared.

The upper-air data discussed above are based on 5 a. m. observations (charts VIII and IX) as well as on observations made at 5 p. m. (table 2, and charts X and XI).

In the United States proper the maximum mean pressure for the month at the 1,000-meter level was 907 mb. over Pensacola. The corresponding maximum at the 1,500-meter level, 854 mb., was recorded at three stations, Pensacola, Miami, and Brownsville, while the maximum mean pressure at the five next higher standard levels were observed over both Brownsville and Miami. At each of the levels from 6,000 to 12,000 meters the maximum pressure occurred over Miami. At 13,000, 14,000, and 15,000 meters the maximum was observed over Brownsville and Miami, while at 16,000 and 17,000 meters it was observed over Brownsville. The lowest mean monthly pressure for the month at the 1,000-meter, 1,500-meter, and 2,000-meter levels were observed over Portland, Maine, and were observed over both Portland, Maine, and Sault Ste. Marie, Mich., at 2,500 and 3,000 meters, while the minimum occurred over Sault Ste. Marie at each of the standard levels from 4,000 to 17,000 meters.

At each of the standard levels below 13,000 meters, mean pressures for the month at Alaska stations were lower than corresponding minima for stations in the United States proper, while at all standard levels below 18,000 meters the mean pressures at Swan Island were higher than the corresponding maxima for the United States.

Mean pressures were the same or higher in January than in the previous month at standard levels below 2,500 meters over most stations west of the Atlantic Coast region, while at these levels pressures at stations along the Atlantic were lower than last month. Pressures at 3,000 and 4,000 meters were lower than last month at many stations while, with but few exceptions, pressures at standard levels from 5,000 to 19,000 meters were lower than last month over all parts of the country.

There was a difference of 30 mb. between the highest and the lowest mean monthly pressures recorded at the 7,000-meter level over stations within the United States proper. This was the largest difference recorded between mean pressure values at any standard level. Steep pressure gradients appear on the mean pressure charts extending from north to south, across the eastern third of the country, particularly at the standard levels from 6,000 to 10,000 meters. At the 8,000-, 9,000-, and 10,000-meter levels a change of 1 mb. in mean pressure was recorded for each 37 miles of the horizontal distance between Buffalo, N. Y., and Washington, D. C.

At all standard levels below 12,000 meters, temperatures were generally lower than in December. At the higher levels from 13,000 to 19,000 meters temperatures were also lower than last month over the extreme Northwest, the North Central States, and the upper Great Lakes, but were generally higher than in December over the rest of the country.

Mean temperatures for all standard levels below 2,500 meters were considerably higher for January 1941 than for the corresponding month of 1940 over most of the United States. Temperatures were lower than last year at most of these levels, however, along the Pacific coast and over the extreme Southwest. At standard levels from 2,500 to 6,000 meters the mean temperatures were also higher than last year over most of the country. The area at which temperatures at these levels were lower than last year was larger than at the lower levels, having extended over the West-Central States, all of the southwest and over the Gulf coast. At levels above 12,000 meters, temperatures were higher than last year over the extreme West, and over the South Central States, and generally lower over the rest of the country. The temperatures were considerably higher than last year over the Central States, for example, at Omaha the average mean temperatures for the surface and the four next higher standard levels were 8° C. higher than the corresponding average for the month of January 1940.

Except along the Pacific coast the January mean surface temperatures as recorded by radiosonde observations were 0° C. or lower over the northern half of the country. At Spokane, where the mean surface temperature was −1.4° C. inversions recorded during the month resulted in an average of 0° being recorded between the surface and 1,000 meters and again at 1,600 meters (m. s. l.). Over the rest of the United States, the altitude at which a mean temperature of 0° C. was recorded during January varied from only about 150 meters above the surface at St. Louis, Mo., to 3,200 meters (m. s. l.) over both Brownsville and Miami. Average freezing temperature occurred at lower levels than last month at all stations in the United States, occurring 200 or 300 meters lower than last month along the Gulf coast and 1,200 meters lower over Norfolk.

The lowest temperature recorded in the free air over the United States during the month was −87.9° C. (−126.2° F.) recorded on January 2, at a height of 16,900 meters (about 12 miles) above sea-level over Miami, Fla. Only two Weather Bureau radiosonde stations in the United States reported the lowest observed air temperature for the month higher than −70° C.

Table 3 shows the maximum free-air wind velocities and their direction for various sections of the United States during January as determined by pilot-balloon observations. The highest wind reported for the month was 76.8 meters per second (149.4 miles per hour) observed over Greensboro, N. C., on January 6. This high wind was blowing from the WSW. at an altitude of 9,840 meters (about 6 miles) above sea-level. Pilot-balloon data showing maximum winds now extend over the 5-year period, 1937 to 1941. In the free-air layer below 2,500 meters the highest wind velocity in January during this period was 50.2 m. p. s., over Wichita, Kans. in 1939. In the free-air layer from 2,500 to 5,000 meters the maximum for

the month was 74.6 m. p. s. over Abilene, Tex., in 1938, while at levels above 5,000 meters the corresponding extreme was 95.5 m. p. s. over Albuquerque, N. Mex., in 1939.

Tropopause data for January showing the mean altitude and temperature of the tropopauses at various stations are shown in table 4 and on chart XIII.

The mean monthly isentropic chart (chart XII) is temporarily discontinued with this issue of the MONTHLY WEATHER REVIEW. This action has been taken because the value of this chart during the winter months is considered questionable.

CORRECTION

Temperature data for Oakland, Calif. shown in table 1 for January 1940 (MONTHLY WEATHER REVIEW, January 1940), have been found to be in error for the levels, 9,000 to 19,000 meters, inclusive. The correct values for these levels are respectively: −44.6, −52.2, −57.9, −59.8, −59.7, −60.2, −61.7, −63.5, −64.5, −64.1, and −64.1.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during January 1941*

Stations with elevations in meters above sea level

Altitude (meters) m. s. l.	Anchorage, Alaska (41 m.)				Atlantic Station No. 1 (3 m.) [3]				Atlantic Station No. 2 (3 m.) [4]				Barrow, Alaska (6 m.)				Bethel, Alaska (7 m.)				Bismarck, N. Dak. (505 m.)				Brownsville, Tex. (6 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	997	−9.3	80	16	1,016	13.5	76	27	1,016	14.7	80	31	1,020	−25.3	90	31	1,003	−20.2	72	31	960	−11.7	88	31	1,018	15.5	89
500	31	940	−4.9	74	16	958	9.3	80	27	957	10.0	86	31	954	−21.4	86	31	940	−10.4	66					31	961	15.2	83
1,000	31	882	−4.4	69	16	902	5.8	85	27	902	6.3	90	31	891	−19.2	81	31	881	−8.9	60	30	901	−7.5	86	31	906	12.7	80
1,500	31	827	−7.3	68	16	848	2.3	89	26	848	3.8	87	31	833	−18.1	76	31	826	−9.9	52	30	845	−5.5	78	31	854	10.8	69
2,000	31	776	−10.5	68	15	797	−.6	87	25	797	1.7	79	31	779	−19.0	73	31	774	−12.4	48	30	792	−5.3	73	31	804	9.3	56
2,500	31	726	−13.6	67	15	748	−2.3	78	24	749	−.5	72	31	728	−20.7	69	31	724	−14.9	43	30	744	−7.1	70	31	757	7.2	51
3,000	31	680	−17.0	67	15	702	−4.7	70	23	703	−3.5	70	31	680	−22.7	67	31	677	−18.0	41	30	697	−9.3	67	31	712	4.7	46
4,000	31	594	−24.1	65	14	618	−9.9	60	21	618	−9.6	66	31	592	−28.3	65	31	592	−24.5	39	30	612	−15.1	63	31	629	−1.5	41
5,000	31	517	−31.1	61	13	542	−16.3	54	20	542	−16.0	62	30	514	−35.0	63	31	515	−31.1	38	30	536	−21.5	60	31	554	−8.5	39
6,000	30	448	−38.1	61	10	473	−22.9	54	19	474	−23.1	60	29	445	−42.0	----	29	446	−38.2	38	31	467	−28.8	56	31	486	−15.5	36
7,000	30	387	−44.9	----	9	412	−29.9	53	17	412	−30.6	59	28	383	−48.9	----	28	385	−44.8	----	30	405	−36.3	55	31	425	−22.7	36
8,000	30	332	−51.0	----	7	356	−37.4	----	13	357	−38.1	57	27	328	−55.2	----	28	331	−50.7	----	30	350	−43.6	----	31	370	−29.6	36
9,000	30	285	−54.5	----	6	307	−43.8	----	10	307	−45.6	----	27	280	−59.8	----	28	284	−53.9	----	30	300	−50.8	----	31	321	−37.0	36
10,000	30	244	−53.1	----	5	264	−49.3	----	10	264	−52.4	----	26	239	−60.8	----	27	242	−53.2	----	30	257	−56.9	----	31	277	−44.1	----
11,000	30	209	−51.1	----					9	226	−58.6	----	24	204	−59.2	----	27	208	−50.9	----	28	220	−59.7	----	30	238	−49.6	----
12,000	30	179	−49.8	----					9	191	−60.4	----	24	174	−57.6	----	27	178	−49.1	----	28	187	−59.3	----	30	204	−33.9	----
13,000	26	154	−49.7	----					9	163	−60.4	----	21	148	−57.9	----	25	153	−47.9	----	27	160	−58.2	----	29	175	−37.9	----
14,000	25	132	−49.5	----					7	138	−60.2	----	16	126	−57.8	----	23	131	−47.9	----	27	136	−57.2	----	29	149	−62.2	----
15,000	22	113	−49.7	----					6	117	−62.9	----	10	108	−57.8	----	20	113	−47.4	----	23	116	−58.3	----	26	126	−66.5	----
16,000	18	97	−50.1	----					5	99	−64.4	----	5	92	−57.6	----	18	97	−47.2	----	17	99	−59.6	----	23	107	−69.7	----
17,000	11	83	−50.7	----													14	83	−47.6	----	7	84	−60.2	----	21	90	−71.9	----
18,000																	6	71	−48.5	----					15	76	−70.7	----
19,000																									5	65	−67.8	----
20,000																									5	55	−65.3	----

Stations with elevations in meters above sea level

Altitude (meters) m. s. l.	Buffalo, N. Y. (221 m.)				Charleston, S. C. (14 m.)				Coco Solo, C. Z. (15 m.) [1 2]				Denver, Colo. (1616 m.)				El Paso, Tex. (1193 m.)				Ely, Nev. (1908 m.)				Fairbanks, Alaska (153 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	15	992	−4.9	89	31	1,019	6.6	82	23	1,013	25.8	87	31	838	−3.5	68	31	884	6.4	63	31	810	−3.9	86	31	991	−21.6	69
500	15	959	−5.4	88	31	961	8.8	66	23	957	23.2	92													31	947	−16.6	72
1,000	15	898	−7.5	89	31	904	6.8	61	23	904	19.8	92													30	886	−13.7	71
1,500	15	843	−8.3	86	31	851	4.9	54	23	853	17.0	75													30	830	−12.1	68
2,000	15	789	−9.1	82	31	800	3.1	48	23	804	14.4	70	31	799	−.3	66	31	801	4.2	61	31	800	−3.1	85	30	777	−13.2	65
2,500	15	740	−10.4	79	31	752	.6	46	23	757	13.3	46	30	750	−2.3	58	31	753	1.7	58	31	752	−3.8	78	30	727	−15.7	64
3,000	15	693	−12.4	75	31	706	−1.8	44	21	714	11.1	31	30	704	−5.7	55	31	708	−1.4	54	31	705	−6.4	75	30	680	−18.8	64
4,000	15	607	−17.6	70	31	622	−7.0	38	19	632	5.2	21	30	618	−12.3	56	31	623	−8.1	49	31	620	−11.8	71	29	594	−25.6	63
5,000	15	531	−23.9	66	31	547	−12.7	39					30	542	−19.1	55	30	548	−14.4	47	31	543	−18.5	62	29	516	−32.7	62
6,000	15	462	−30.9	62	30	479	−20.0	41					30	473	−26.1	53	29	479	−21.5	44	31	474	−25.6	57	28	447	−39.9	61
7,000	15	400	−38.5	60	29	418	−27.0	41					30	410	−33.7	52	28	417	−28.8	42	31	412	−32.9	54	27	385	−46.9	----
8,000	14	345	−46.8	----	29	363	−34.5	41					30	355	−42.1	----	27	362	−36.8	41	31	357	−40.6	----	26	330	−52.5	----
9,000	14	296	−52.4	----	29	313	−42.3	----					29	305	−49.8	----	26	312	−44.3	----	31	307	−48.8	----	24	282	−56.3	----
10,000	14	253	−56.8	----	28	270	−49.8	----					27	261	−56.3	----	25	268	−51.1	----	31	263	−55.7	----	24	241	−56.0	----
11,000	12	216	−57.8	----	27	231	−55.7	----					27	223	−58.6	----	25	230	−56.3	----	30	225	−59.3	----	24	206	−53.8	----
12,000	12	185	−55.9	----	27	197	−57.2	----					25	190	−59.1	----	22	196	−57.0	----	30	192	−58.2	----	22	176	−52.7	----
13,000	11	157	−56.4	----	27	168	−57.6	----					24	162	−58.0	----	20	167	−57.4	----	30	164	−56.8	----	20	150	−52.5	----
14,000	11	134	−57.3	----	26	144	−59.9	----					22	138	−58.7	----	17	142	−61.3	----	29	140	−58.0	----	16	128	−52.3	----
15,000	8	115	−59.1	----	24	122	−63.4	----					19	118	−60.8	----	17	120	−64.8	----	27	119	−60.0	----	7	110	−51.8	----
16,000	7	98	−60.0	----	24	104	−66.1	----					12	100	−62.3	----	17	102	−67.2	----	26	101	−61.6	----	5	93	−51.7	----
17,000					23	88	−67.6	----					10	85	−63.4	----	16	86	−67.5	----	22	86	−62.6	----				
18,000					23	75	−67.1	----					5	73	−63.8	----	13	73	−65.8	----	13	73	−63.0	----				
19,000					17	63	−65.3	----									5	61	−64.7	----								
20,000					10	53	−64.3	----																				

See footnotes at end of table.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during January 1941*—Continued

Stations with elevations in meters above sea level

Altitude (meters) m. s. l.	Great Falls, Mont. (1,117 m.)				Joliet, Ill. (178 m.)				Juneau, Alaska (49 m.)				Ketchikan, Alaska (26 m.)				Lakehurst, N. J.[1] (39 m.)[4]				Medford, Oreg. (401 m.)				Miami, Fla. (4 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	887	−2.1	64	31	1,000	−3.3	91	28	1,001	0.0	75	31	1,004	3.7	77	31	1,016	−3.2	80	31	967	4.6	86	31	1,019	15.8	90
500					31	959	−4.9	92	28	946	−2.3	73	31	947	1.3	78	31	957	−3.7	72	31	956	5.4	82	31	962	15.8	82
1,000					31	900	−5.2	86	28	888	−4.4	73	31	890	−1.7	79	31	899	−3.9	69	31	899	5.2	69	31	906	12.9	80
1,500	31	846	−.8	65	31	845	−4.5	77	27	833	−6.8	72	29	834	−4.2	81	31	844	−4.5	63	31	845	3.0	65	31	854	10.7	72
2,000	31	795	−2.3	65	31	793	−5.5	74	26	781	−9.0	72	29	783	−6.9	81	31	792	−6.1	62	31	794	.2	65	31	804	9.1	57
2,500	31	746	−4.5	65	31	744	−7.6	71	25	731	−11.9	72	29	734	−10.0	78	31	743	−7.6	60	31	746	−2.7	65	31	757	7.0	48
3,000	31	700	−7.8	65	31	697	−10.2	69	24	685	−14.7	70	28	688	−13.0	75	31	696	−10.2	57	31	700	−5.5	64	31	712	4.6	42
4,000	31	615	−14.1	64	29	612	−15.7	62	22	599	−21.6	66	28	602	−19.8	69	30	610	−15.5	51	31	615	−11.8	61	30	629	−1.2	36
5,000	31	538	−20.9	61	29	535	−21.6	58	17	522	−28.3	63	27	525	−26.7	66	29	534	−21.6	53	31	539	−18.5	61	30	554	−7.4	33
6,000	30	469	−27.8	58	29	466	−28.2	55	14	453	−35.4	63	26	456	−34.1	63	24	465	−28.3	52	31	471	−25.4	59	30	487	−14.5	33
7,000	30	407	−35.4	58	29	404	−35.4	53	12	391	−42.6	----	22	394	−41.2	----	24	404	−35.2	53	31	409	−33.0	56	29	426	−21.6	32
8,000	30	352	−42.7	----	29	350	−43.1	----	11	336	−49.2	----	20	338	−48.4	----	24	350	−42.1	----	31	354	−41.3	----	29	371	−28.5	32
9,000	30	302	−50.3	----	28	301	−50.5	----	11	288	−53.6	----	18	290	−53.6	----	24	301	−48.1	----	31	304	−49.3	----	29	322	−35.5	32
10,000	30	259	−56.7	----	28	257	−56.0	----	10	246	−53.1	----	16	248	−56.2	----	22	259	−51.9	----	31	261	−56.0	----	29	279	−42.7	----
11,000	30	221	−60.2	----	28	220	−58.4	----	9	211	−50.4	----	14	212	−53.3	----	22	222	−53.6	----	31	223	−59.9	----	28	240	−49.4	----
12,000	30	188	−61.5	----	28	187	−56.6	----	8	181	−48.4	----	13	181	−50.9	----	22	190	−54.5	----	31	190	−58.7	----	28	205	−55.4	----
13,000	30	160	−59.1	----	27	160	−56.3	----	8	154	−48.0	----	9	155	−50.2	----	21	162	−55.1	----	31	162	−56.8	----	27	175	−60.3	----
14,000	29	137	−57.5	----	27	136	−57.7	----	8	132	−48.4	----	7	133	−50.5	----	18	139	−56.9	----	31	138	−57.7	----	26	149	−66.1	----
15,000	29	117	−58.0	----	27	116	−59.0	----	5	114	−47.6	----	5	114	−50.2	----	15	119	−59.1	----	29	118	−58.8	----	26	126	−71.8	----
16,000	26	99	−59.5	----	27	99	−60.3	----					5	97	−51.1	----	14	101	−60.3	----	27	101	−59.9	----	25	106	−75.7	----
17,000	18	84	−60.0	----	24	85	−61.2	----									9	86	−61.5	----	26	86	−60.1	----	21	89	−75.2	----
18,000	10	72	−61.1	----	13	72	−62.0	----													23	73	−60.1	----	18	76	−71.9	----
19,000																					13	62	−59.8	----	13	64	−68.3	----

Stations with elevations in meters above sea level

Altitude (meters) m. s. l.	Nashville, Tenn. (180 m.)				Nome, Alaska (14 m.)				Norfolk, Va.[1][2] (10 m.)				Oakland, Calif. (2 m.)				Oklahoma City, Okla. (391 m.)				Omaha, Nebr. (301 m.)				Pearl Harbor[1][2] (6 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	1,000	3.1	78	31	1,009	−14.2	68	24	1,024	1.5	74	31	1,017	9.8	86	31	974	3.3	87	31	986	−4.3	87	31	1,016	20.4	85
500	31	961	3.0	76	31	947	−13.6	70	24	963	.5	63	31	958	9.5	75	31	962	3.8	85	31	962	−4.2	85	31	960	19.7	79
1,000	31	904	2.1	71	31	887	−13.3	68	24	905	.3	55	31	902	7.0	69	31	904	4.1	73	31	903	−2.5	75	31	906	16.9	76
1,500	31	850	1.0	66	31	830	−13.4	64	24	850	−.9	50	31	849	4.5	64	31	850	3.9	64	31	848	−2.1	67	31	854	14.6	68
2,000	31	798	−.5	62	31	777	−14.9	59	24	798	−2.9	45	31	798	2.1	60	31	799	2.4	58	31	795	−3.0	62	31	805	13.8	45
2,500	31	749	−2.4	60	31	727	−17.0	56	24	748	−4.6	37	31	750	−.7	57	31	751	−.5	56	31	747	−5.2	59	31	759	12.5	25
3,000	31	703	−4.6	55	31	680	−19.7	54	24	702	−6.8	32	31	704	−3.5	53	30	705	−3.3	53	31	700	−7.3	58	31	715	10.2	19
4,000	30	619	−9.9	48	30	593	−25.8	53	24	617	−11.8	32	31	620	−9.5	50	30	621	−9.3	49	31	615	−12.5	54	31	633	4.4	14
5,000	30	543	−16.2	46	30	516	−32.5	52	21	541	−17.8	33	31	544	−15.6	51	29	545	−16.0	47	31	539	−19.1	51				
6,000	29	475	−23.0	44	29	447	−39.8	51					31	476	−22.9	51	28	476	−23.4	45	30	470	−26.5	49				
7,000	28	413	−30.3	43	27	385	−47.0	----					31	414	−30.6	49	28	414	−31.3	44	29	409	−34.4	47				
8,000	28	358	−38.3	41	26	330	−52.9	----					31	359	−38.8	48	28	359	−39.7	43	28	354	−42.3					
9,000	28	309	−45.9	----	26	283	−56.4	----					30	309	−46.6	----	27	310	−46.4	----	28	304	−49.7					
10,000	28	265	−52.6	----	26	242	−57.1	----					29	265	−52.9	----	25	266	−52.2	----	28	260	−55.1					
11,000	28	227	−57.1	----	25	207	−54.8	----					28	227	−56.6	----	23	228	−55.6	----	26	222	−58.4					
12,000	28	194	−57.7	----	25	177	−52.5	----					28	194	−56.8	----	21	194	−57.1	----	24	190	−58.1					
13,000	27	166	−56.7	----	24	152	−51.5	----					27	165	−55.9	----	21	166	−57.7	----	23	162	−57.3					
14,000	26	141	−58.3	----	24	130	−51.1	----					26	141	−57.4	----	20	141	−59.3	----	22	139	−58.2					
15,000	24	120	−61.1	----	22	112	−50.9	----					24	120	−59.8	----	16	120	−61.1	----	19	118	−59.7					
16,000	21	102	−62.9	----	17	95	−50.6	----					23	102	−61.9	----	13	102	−63.0	----	18	101	−61.0					
17,000	16	87	−63.2	----	10	82	−50.5	----					21	87	−62.6	----	5	87	−62.8	----	13	86	−61.4					
18,000	6	74	−62.9	----	6	70	−50.4	----					16	74	−62.4	----					7	74	−62.1					
19,000													7	62	−61.6	----												

See footnotes at end of table.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during January 1941*—Continued

Altitude (meters), m. s. l.	Stations with elevations in meters above sea level																							
	Pensacola, Fla.[1] (24 m.)				Phoenix, Ariz. (339 m.)				Portland, Maine (9 m.)				San Diego, Calif.[1] (19 m)				St. Louis, Mo. (171 m.)				St. Paul, Minn. (214 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	29	1,019	10.7	73	31	978	9.8	83	30	1,016	−9.4	77	30	1,015	13.4	85	18	999	0.6	85	30	995	−8.2	85
500	29	963	10.4	62	31	960	12.3	70	30	955	−7.3	77	30	958	12.3	69	18	959	−0.5	87	30	960	−9.7	87
1,000	29	907	9.0	52	31	904	10.4	60	30	896	−8.3	76	30	902	9.5	64	18	901	−1.0	82	30	900	−7.6	84
1,500	29	854	7.1	46	31	851	7.1	61	30	840	−8.5	73	30	850	6.5	60	18	847	−1.3	76	30	844	−6.3	76
2,000	29	803	5.6	40	31	800	3.8	60	30	787	−9.4	72	30	800	4.4	49	18	795	−2.1	68	30	791	−7.5	72
2,500	29	755	3.2	39	31	752	0.8	58	30	738	−10.9	70	30	751	2.1	42	18	746	−3.7	64	30	742	−9.5	71
3,000	29	709	0.5	37	31	706	−2.2	55	30	691	−13.2	69	30	706	−0.6	41	18	700	−6.4	62	30	695	−12.0	68
4,000	27	626	−4.9	34	31	622	−8.4	46	30	606	−18.3	66	28	622	−7.1	46	18	616	−12.5	58	28	609	−17.1	63
5,000	25	550	−11.8	36	31	546	−15.3	42	30	529	−23.8	64	28	546	−13.5	46	18	539	−19.1	54	25	532	−23.3	60
6,000	24	482	−18.9	38	31	478	−22.6	39	30	461	−30.4	64	28	478	−20.7	47	18	471	−25.7	52	25	464	−29.9	57
7,000	24	421	−26.1	41	30	416	−30.1	38	30	399	−37.8	62	28	417	−28.2	46	16	409	−33.2	49	25	402	−37.1	56
8,000	22	365	−33.5	41	30	361	−38.0	38	29	344	−44.9	.....	27	361	−35.9	.....	15	355	−41.2	.....	25	347	−44.7	.....
9,000	20	315	−40.6	.....	26	311	−45.6	.....	27	295	−51.1	.....	27	312	−43.4	.....	13	305	−49.5	.....	20	298	−52.7	.....
10,000	19	272	−48.0	.....	26	267	−51.7	.....	27	253	−55.1	.....	26	268	−49.0	.....	13	262	−56.7	.....	19	254	−59.8	.....
11,000	16	233	−53.9	.....	26	229	−56.7	.....	27	217	−55.5	.....	24	230	−52.5	.....	11	224	−61.0	.....	18	217	−62.7	.....
12,000	15	199	−56.4	.....	25	196	−56.6	.....	25	186	−54.2	.....	22	197	−54.4	.....	10	190	−59.6	.....	16	184	−61.0	.....
13,000	11	170	−58.3	.....	23	167	−56.5	.....	20	158	−54.8	.....	20	168	−54.9	.....	7	162	−57.6	.....	14	156	−59.2	.....
14,000	6	145	−60.7	.....	22	142	−58.9	.....	19	136	−55.7	.....	18	144	−57.3	.....	7	138	−58.8	.....	14	133	−59.4	.....
15,000					16	121	−61.6	.....	17	116	−56.9	.....	17	123	−60.2	.....	6	118	−60.7	.....	12	113	−60.1	.....
16,000					12	103	−63.6	.....	14	99	−57.9	.....	14	104	−62.3	.....	5	100	−61.8	.....	10	96	−61.4	.....
17,000					9	88	−64.3	.....	12	84	−59.1	.....	11	89	−63.2	.....					7	81	−63.2	.....
18,000					5	75	−64.0	.....	7	71	−60.4	.....												

Altitude (meters), m. s. l.	Stations with elevations in meters above sea level																			
	Sault Ste. Marie, Mich. (221 m.)				Seattle, Wash.[1] (27 m.)				Spokane, Wash. (598 m.)				Swan Island, West Indies (10 m.)				Washington, D. C.[1,2] (7 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	994	−10.6	81	17	1,012	6.2	88	31	947	−1.4	95	31	1,014	24.4	80	24	1,022	0.0	77
500	31	959	−11.0	87	17	955	5.3	75					31	959	21.4	83	24	960	−1.7	75
1,000	31	898	−11.5	88	17	898	2.8	73	31	901	0.9	89	31	905	18.2	80	24	902	−2.7	74
1,500	31	841	−11.7	86	17	843	−0.1	70	31	847	0.4	79	31	854	15.3	75	24	847	−3.1	69
2,000	31	788	−12.2	83	17	792	−3.0	66	31	795	−1.9	73	31	804	12.8	70	24	795	−4.4	65
2,500	31	738	−13.4	77	17	743	−5.7	61	31	747	−4.3	71	31	758	11.1	64	24	746	−6.2	59
3,000	31	691	−15.5	72	17	697	−8.6	56	31	700	−7.1	67	31	714	8.7	56	24	699	−8.3	56
4,000	31	604	−20.6	69	17	612	−14.5	56	30	615	−13.1	62	30	632	4.4	40	24	613	−13.6	53
5,000	31	527	−26.9	65	17	535	−21.4	60	30	539	−19.8	55	30	559	−1.3	34	22	537	−20.1	55
6,000	31	458	−33.6	65	17	467	−28.7	58	30	470	−26.8	52	30	492	−7.9	33	21	468	−26.9	56
7,000	31	396	−40.1	.....	17	405	−36.2	55	30	407	−34.6	51	30	432	−15.0	31	21	407	−33.5	53
8,000	31	342	−47.0	.....	16	350	−43.9	.....	30	353	−42.5	.....	30	377	−22.1	30	9	353	−41.6	.....
9,000	31	293	−53.7	.....	16	301	−51.3	.....	30	303	−50.1	.....	30	328	−28.9	29	9	304	−47.9	.....
10,000	26	250	−57.9	.....	16	258	−57.1	.....	29	260	−56.6	.....	29	285	−35.9	28	9	261	−53.7	.....
11,000	25	214	−58.1	.....	16	220	−59.1	.....	28	222	−59.8	.....	29	246	−44.1	.....				
12,000	24	183	−56.9	.....	16	188	−57.7	.....	27	189	−59.4	.....	29	212	−51.6	.....				
13,000	21	156	−56.7	.....	15	161	−56.2	.....	27	161	−56.8	.....	29	181	−59.2	.....				
14,000	17	133	−57.3	.....	15	138	−55.4	.....	26	138	−56.3	.....	29	154	−67.0	.....				
15,000	16	113	−58.5	.....	15	118	−55.5	.....	25	118	−56.8	.....	28	130	−75.1	.....				
16,000	12	96	−59.7	.....	15	100	−58.5	.....	19	100	−57.1	.....	28	109	−81.9	.....				
17,000	7	82	−61.1	.....	10	85	−57.8	.....	14	86	−57.6	.....	27	91	−84.4	.....				
18,000									9	73	−58.7	.....	26	76	−81.1	.....				
19,000													20	64	−73.6	.....				
20,000													15	54	−66.8	.....				
21,000													6	46	−62.6	.....				

[1] U. S. Navy.
[2] Airplane observations.
[3] Observations made on Coast Guard vessels in or near the 5° square:
Lat. 35°00′ N. to 40°00′ N.
Long. 55°00′ W. to 60°00′ W.
[4] Observations made on Coast Guard vessels in or near the 5° square:
Lat. 35°00′ N. to 40°00′ N.
Long. 45°00′ W. to 50°00′ W.
[5] Radiosonde and airplane observations.

NOTE.—All observations taken at 12:30 a. m., 75th meridian time, except at Washington, D. C., and Lakehurst, N. J., where they are taken near 5 a. m. E. S. T., and at Norfolk, Va., where they are taken at about 6 a. m., and at Pearl Harbor, T. H., after sunrise.

None of the means included in this table are based on less than 15 surface or 5 standard level observations.

Number of observations refers to pressure only as temperature and humidity data are missing / / some observations at certain levels, also, the humidity data are not used in daily observations when the temperature is below −40.0° C.

TABLE 2.—*Free-air resultant winds based on pilot balloon observations made near 5 p. m. (75th meridian time) during January 1941. Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°)—Velocities in meters per second*

Altitude (meters) m. s. l.	Abilene, Tex. (537 m.)			Albuquerque, N. Mex. (1,630 m.)			Atlanta, Ga. (299 m.)			Billings, Mont. (1,095 m.)			Bismarck, N. Dak. (512 m.)			Boise, Idaho (870 m.)			Brownsville, Tex. (7 m.)			Buffalo, N. Y. (220 m.)			Burlington Vt. (132 m.)			Charleston, S. C. (18 m.)			Chicago, Ill. (192 m.)			Cincinnati, Ohio (157 m.)			Denver, Colo. (1,627 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	30	264	2.3	31	325	0.8	27	296	2.7	31	233	3.6	28	305	1.3	28	125	0.7	28	124	2.3	30	282	1.9	29	57	0.6	31	316	1.2	26	289	1.2	30	290	1.3	30	1	1.3
500							27	301	4.0										28	124	2.9	30	259	2.9	29	277	.8	31	304	1.9	26	275	2.4	30	264	2.1			
1,000	30	252	2.8				26	300	4.7				28	285	4.1	28	118	1.5	25	159	3.0	21	264	5.2	28	285	4.7	30	279	4.8	20	291	4.9	21	250	5.0			
1,500	27	250	5.2				26	291	6.4	31	249	5.0	25	296	5.9	28	156	3.8	21	204	2.6	11	286	6.2	25	310	5.7	28	276	8.4	15	285	8.4	18	276	6.5			
2,000	22	252	7.4	31	312	1.2	23	298	9.5	30	282	4.9	20	290	8.8	27	181	4.1	17	236	2.9				17	310	8.4	25	277	10.4	13	297	10.5	15	275	10.8	30	15	1.1
2,500	20	257	9.4	30	279	3.3	23	295	11.1	29	285	8.0	19	289	10.8	23	204	4.8	13	257	4.1				14	307	9.6	24	273	11.1	13	295	11.6	10	278	10.8	30	309	2.4
3,000	19	261	11.0	28	275	5.7	23	290	12.6	26	290	8.7	19	295	12.5	21	212	4.9	13	253	5.2				10	299	10.5	21	276	12.4	13	299	14.3	10	284	12.6	29	299	5.1
4,000	18	259	13.9	21	278	8.2	22	282	15.8	24	294	8.5	18	297	15.5	19	217	5.6	12	263	8.0							13	272	14.1	10	305	17.0				27	291	5.1
5,000	16	266	13.3	21	264	10.8	21	288	16.7	21	297	11.7	16	299	16.4	17	255	3.1	11	264	10.5															25	303	6.5
6,000	15	268	15.0	18	286	11.8	19	292	21.6	16	295	10.7	14	299	19.6	15	263	4.8																			21	295	7.7
8,000	11	279	20.8	15	298	13.4	16	292	26.6	12	307	14.3	11	302	17.3	14	283	5.3																			14	302	10.8
10,000				11	261	20.9	11	300	29.3							11	322	5.2																			10	297	10.3

Altitude (meters) m. s. l.	El Paso, Tex. (1,196 m.)			Ely, Nev. (1,910 m.)			Grand Junction, Colo. (1,413 m.)			Greensboro, N. C. (271 m.)			Havre, Mont. (766 m.)			Jacksonville, Fla. (14 m.)			Las Vegas, Nev. (570 m.)			Little Rock, Ark. (79 m.)			Medford, Oreg. (410 m.)			Miami, Fla. (10 m.)			Minneapolis, Minn. (261 m.)			Mobile, Ala. (10 m.)			Nashville, Tenn. (194 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	31	316	1.7	31	274	0.2	29	86	0.4	25	292	2.1	28	246	1.2	29	351	1.4	31	79	1.6	28	227	0.8	25	59	0.6	31	34	1.4	28	293	1.5	30	290	0.5	30	280	0.8
500										25	287	3.7				27	256	1.2				28	261	2.3	25	65	.8	31	34	1.6	28	290	1.8	30	325	1.5	30	256	1.7
1,000										24	296	4.4	28	248	4.4	26	264	2.9	31	52	2.5	26	264	4.5	23	154	4.2	31	291	.7	20	310	4.8	27	343	1.9	21	258	3.8
1,500	31	316	1.2				29	88	.5	24	287	7.3	28	269	8.2	26	276	4.3	31	76	1.1	24	271	6.7	23	179	5.5	30	271	3.0	19	301	7.8	27	308	4.3	18	289	6.2
2,000	29	271	2.4	31	245	0.3	29	90	.8	24	295	9.8	28	277	10.4	26	275	6.4	30	220	1.5	23	279	8.5	22	203	8.3	27	285	4.6	17	308	10.5	25	294	6.7	17	294	8.5
2,500	24	266	6.3	31	234	1.4	27	185	1.4	23	292	12.9	28	282	12.0	26	286	7.8	28	229	2.3	21	286	8.6	19	210	8.6	25	283	5.5	13	310	12.1	24	296	8.9	17	289	10.6
3,000	24	270	8.9	31	231	2.6	27	237	2.4	21	297	15.1	26	286	11.8	25	293	9.8	27	246	2.8	20	289	10.4	15	205	8.7	25	283	7.0	13	314	14.8	23	287	10.7	14	283	12.1
4,000	21	279	13.5	23	245	4.1	20	287	4.2	18	287	18.2	24	289	13.4	22	290	10.7	26	279	5.3	18	297	13.9	11	200	6.1	23	282	9.7	11	310	17.5	22	285	14.4	11	282	13.2
5,000	15	288	14.4	20	278	6.1	17	278	6.0	16	286	23.0	21	283	15.8	22	287	13.5	24	294	6.7	15	280	15.8				21	280	12.0				15	296	17.0			
6,000	12	303	16.1	16	290	3.1	16	286	8.2	15	287	25.8	13	286	17.7	20	287	15.8	22	305	10.7							19	279	15.7									
8,000				13	287	4.7										13	282	22.6	16	321	18.9							13	286	25.6									
10,000																10	282	31.2	11	319	18.4																	
12,000																			10	296	24.4																	

Altitude (meters) m. s. l.	New York, N. Y. (15 m.)			Oakland, Calif. (8 m.)			Oklahoma City, Okla. (402 m.)			Omaha, Nebr. (306 m.)			Phoenix, Ariz. (344 m.)			Rapid City, S. Dak. (982 m.)			St. Louis, Mo. (181 m.)			San Antonio, Tex. (183 m.)			San Diego, Calif. (15 m.)			Sault Ste. Marie, Mich. (230 m.)			Seattle, Wash. (14 m.)			Spokane, Wash. (603 m.)			Washington, D. C. (10 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	27	313	4.8	30	174	1.5	24	251	1.5	25	301	2.4	31	80	0.5	29	360	2.8	23	262	1.8	30	24	0.9	31	277	2.4	28	332	1.2	26	175	1.1	22	84	1.0	25	283	2.8
500	26	306	6.1	30	165	2.5	24	230	1.8	25	313	3.3	31	85	1.1				22	257	4.0	30	68	1.1	31	286	1.7	28	308	1.6	26	167	3.8				25	290	6.0
1,000	25	314	7.4	27	205	3.6	23	246	3.2	22	298	5.0	31	108	1.8	29	354	2.9	18	276	6.0	27	212	1.3	26	66	0.6	25	303	3.7	24	190	5.9	22	150	2.2	23	291	7.5
1,500	19	310	10.7	25	217	4.9	20	249	6.1	15	304	8.4	31	158	1.5	29	315	5.4	18	285	7.9	24	231	3.0	26	105	0.7	21	296	5.1	21	205	7.0	19	200	5.2	19	303	9.4
2,000	14	303	11.8	25	221	4.7	19	267	6.8	14	303	9.6	29	192	2.0	27	310	8.5	17	288	10.4	22	247	4.9	26	250	0.8	19	301	6.[illegible]	21	209	6.8	17	213	6.3	16	301	10.0
2,500	10	306	14.2	22	214	4.6	15	285	8.3	13	301	10.5	26	220	2.2	25	307	9.7	15	296	12.9	16	252	7.5	26	261	2.9	18	297	8.[illegible]	17	198	8.2	14	235	6.9	14	299	14.7
3,000				20	238	4.7	15	281	9.4	13	296	11.9	25	238	3.0	25	308	11.2	15	300	14.6	14	259	9.2	24	261	2.9	16	299	8.4	14	210	8.4	13	244	8.4	14	298	14.7
4,000				14	322	3.0	15	276	12.5	13	296	14.1	22	274	6.3	25	298	11.7	15	302	17.3	13	260	13.4	17	267	2.2				12	222	10.4	10	248	10.3	11	293	19.2
5,000				14	306	4.7	15	279	12.8	13	299	14.9	21	274	7.7	24	302	12.6	12	297	18.0	13	261	14.0	14	293	4.1				10	236	10.7						
6,000				12	294	6.2	14	290	15.4	13	303	17.5	19	286	10.3	20	298	13.2	11	302	18.2	11	270	15.4														
8,000				10	333	7.8	12	287	17.9				14	283	12.3	17	305	12.4				10	275	19.7												
10,000							10	277	25.4							16	295	13.4																		
12,000																14	286	16.4																		
14,000																12	297	18.8																		

TABLE 3.—*Maximum free-air wind velocities (m. p. s.) for different sections of the United States based on pilot-balloon observations during January 1941*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station
Northeast [1]	41.0	NW	1,910	14	Caribou, Maine	54.0	WNW	4,420	14	Boston, Mass	58.8	WNW	6,590	26	Caribou, Maine.
East-Central [2]	41.2	WNW	2,500	4	Knoxville, Tenn	64.5	WNW	5,000	4	Louisville, Ky	76.8	WSW	9,840	6	Greensboro, N. C.
Southeast [3]	32.1	W	2,500	16	Mobile, Ala	48.4	W	5,000	4	Jacksonville, Fla	69.4	WNW	9,575	11	Miami, Fla.
		NW	2,500	4	Atlanta, Ga										
North-Central [4]	33.0	NW	2,500	3	Rapid City, S. Dak	56.1	NW	5,000	3	Rapid City, S. Dak	72.1	WNW	11,610	19	Huron, S. Dak.
Central [5]	39.1	NW	2,250	10	Springfield, Ill	68.8	NW	4,420	30	Moline, Ill	63.0	WNW	5,670	4	St. Louis, Mo.
South-Central [6]	34.1	WSW	2,450	16	New Orleans, La	38.8	WSW	4,070	17	New Orleans, La	72.0	W	9,030	16	Houston, Tex.
Northwest [7]	40.1	E	660	5	Tatoosh Island, Wash.	43.8	WSW	3,020	28	Great Falls, Mont	54.0	NW	7,160	3	Havre, Mont.
West-Central [8]	34.8	SSE	2,440	8	Sacramento, Calif	37.2	WNW	3,690	3	Casper, Wyo	60.0	NW	12,110	30	Redding, Calif.
Southwest [9]	41.5	SSE	2,400	8	Bakersfield, Calif	52.8	SSE	3,450	8	Sandberg, Calif	73.8	N	7,380	17	Albuquerque, N. Mex.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except extreme west Texas) and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during January 1941, classified according to the potential temepratures (10° intervals between 290° and 409° A.) with which they are identified (based on radiosonde observations)*

Stations	Anchorage, Alaska			Barrow, Alaska			Bethel, Alaska			Bismarck, N. Dak.			Brownsville, Tex.			Charleston, S. C.			Denver, Colo.		
Potential temperatures ° A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.
290–299	20	6.5	−43.6	26	6.9	−48.5	14	6.5	−43.8	4	6.6	−40.8							1	8.6	−59.0
300–309	26	8.3	−53.6	24	8.8	−59.5	37	8.1	−51.7	18	7.9	−48.5	1	6.0	−26.0	2	6.8	−36.0	11	8.1	−48.2
310–319	14	9.3	−56.1	8	10.0	−63.8	18	9.0	−54.4	22	10.1	−61.7	5	7.7	−32.2	10	8.7	−44.2	28	9.7	−56.9
320–329	3	9.9	−53.7	4	10.4	−62.8	6	10.0	−57.2	16	10.9	−61.7	24	9.1	−38.3	24	10.3	−53.8	14	11.1	−63.0
330–339	2	10.8	−54.5				2	10.6	−57.0	4	11.9	−64.5	20	10.9	−51.0	14	11.3	−56.9	5	12.0	−64.2
340–349							2	10.8	−52.5				9	12.4	−59.0	5	12.4	−60.4			
350–359	2	11.8	−54.5	1	12.6	−64.0	1	10.8	−53.0	1	11.2	−45.0									
360–369				2	12.4	−57.0							4	14.5	−68.2	2	13.8	−63.5	1	13.4	−61.0
370–379				1	13.3	−58.0				2	13.9	−60.0	3	14.9	−65.7	3	14.6	−63.0	1	14.8	−67.0
380–389							1	12.7	−48.0	1	15.0	−67.0	7	16.0	−71.3	4	15.3	−66.2	5	14.7	−61.0
390–399										1	14.4	−53.0	6	16.8	−73.0	7	15.9	−66.9	1	16.0	−66.0
400–409										3	15.9	−63.0	7	16.9	−70.7	9	16.7	−69.2			
Weighted means		8.2	−51.2		8.5	−55.8		8.4	−51.5		10.1	−57.1		11.9	−53.0		12.0	−57.2		10.5	−58.0
Mean potential temperature ° A. (weighted)		307.3			306.1			309.6			322.5			347.8			346.6			324.4	
Number days with observations		24			21			28			30			29			28			29	

Stations	El Paso, Tex.			Ely, Nev.			Fairbanks, Alaska			Great Falls, Mont.			Joliet, Ill.			Ketchikan, Alaska			Lakehurst, N. J.		
Potential temperatures ° A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.
290–299				4	5.6	−31.8	19	7.2	−51.2	4	6.4	−38.8	1	5.9	−38.0	8	6.8	−46.0	3	7.7	−34.3
300–309	5	6.8	−34.8	12	7.7	−43.6	27	8.2	−53.0	17	8.1	−49.5	12	8.3	−49.1	15	8.1	−50.4	11	7.5	−44.6
310–319	12	8.6	−43.9	30	9.6	−55.2	13	9.5	−59.3	19	9.8	−59.2	28	9.7	−56.8	11	9.5	−57.4	19	9.8	−49.7
320–329	24	10.7	−57.8	17	10.9	−61.9				18	11.4	−66.5	16	10.7	−61.4	2	10.4	−59.0	8	10.6	−58.8
330–339	10	11.4	−59.1	6	11.5	−61.8				5	12.3	−68.4	3	11.3	−59.3				2	11.7	−61.0
340–349	1	12.2	−60.0	2	11.9	−54.5										1	11.4	−56.0	1	11.4	−57.0
350–359	2	13.8	−68.5	2	12.8	−60.5							1	11.9	−56.0				1	12.3	−58.0
360–369	4	14.0	−63.5	2	13.0	−57.5							2	13.4	−60.5				3	12.9	−56.7
370–379	1	14.9	−67.0	2	13.8	−59.5				1	12.8	−47.0									
380–389	6	15.4	−68.5	5	15.0	−59.8	1	13.0	−48.0	1	15.1	−63.0	2	14.4	−59.0				2	14.6	−62.0
390–399	6	16.0	−67.8	9	15.3	−62.3	1	13.5	−53.0	4	15.6	−64.0	2	14.8	−57.5	1	14.4	−52.0	1	11.8	−56.0
400–409	6	16.6	−69.2	3	16.2	−65.7				3	16.0	−63.3	2	15.6	−62.5				1	15.7	−64.0
Weighted means		11.8	−57.5		10.9	−55.3		8.3	−53.7		10.5	−58.5		10.3	−56.7		8.6	−52.1		10.0	−51.1
Mean potential temperature ° A. (weighted)		342.6			333.7			306.6			324.9			325.1			310.2			322.3	
Number days with observations		24			30			25			30			28			18			23	

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during January 1941, classified according to the potential temperatures (10° intervals between 290° and 409° A.) with which they are identified (based on radiosonde observations)*—Con.

Stations	Medford, Oreg.			Miami, Fla.			Nashville, Tenn.			Nome, Alaska			Oakland, Calif.			Oklahoma City, Okla.			Omaha, Nebr.		
Potential temperatures ° A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.
290–299	1	5.6	−33.0							13	7.1	−49.7							1	5.7	−32.0
300–309	17	8.3	−51.3				6	7.8	−43.7	17	8.2	−53.1	10	7.9	−45.1	9	7.8	−46.7	18	8.0	−48.2
310–319	21	10.2	−60.5	1	12.1	−56.0	18	9.0	−49.2	14	9.6	−59.3	21	9.1	−48.9	18	8.9	−45.6	25	9.4	−52.6
320–329	19	11.0	−61.3	11	9.1	−39.7	20	10.6	−57.7	3	10.4	−60.7	22	10.8	−58.7	20	10.8	−59.0	12	11.1	−62.4
330–339	3	12.3	−66.7	17	11.2	−53.1	12	11.4	−59.8	2	10.4	−56.0	5	11.7	−59.6	5	11.1	−56.0			
340–349				6	12.7	−61.3	2	11.8	−57.5				1	12.6	−65.0	2	12.8	−65.5	2	12.0	−62.5
350–359	1	12.5	−62.0	8	14.5	−73.0							1	12.8	−62.0	4	12.6	−58.5			
360–369	1	12.5	−58.0	10	15.4	−76.2	4	13.2	−58.8				1	13.6	−60.0	3	13.6	−61.0	1	14.3	−67.0
370–379	3	13.9	−60.7	8	16.1	−77.1	2	14.4	−64.0				2	14.2	−62.5	1	14.2	−60.0	2	13.6	−57.0
380–389	4	14.9	−63.2	3	16.9	−80.0	5	14.9	−63.2				4	14.9	−63.2	1	14.2	−57.0	3	14.9	−63.3
390–399	6	15.1	−59.7	3	16.5	−73.7	5	15.5	−63.4				5	15.4	−62.0	4	15.5	−64.2			
400–409	3	15.5	−60.3	4	17.4	−76.0	3	16.2	−66.0				4	16.2	−65.2	1	16.3	−66.0	3	15.9	−64.0
Weighted means		11.0	−58.7		13.3	−63.3		11.2	−56.2		8.5	−54.6		11.0	−55.3		10.7	−54.2		10.1	−54.5
Mean potential temperature °A (weighted)	332.2			353.5			337.2			306.7			334.8			331.5			324.4	
Number days with observations	31			26			28			21			29			24			26		

Stations	Phoenix, Ariz.			Portland, Maine			St. Paul, Minn.			San Diego, Calif.			Sault Ste Marie, Mich.			Seattle, Wash.			Spokane, Wash.			Swan Island West Indies		
Potential temperatures °A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290–299				3	6.5	−43.0	2	6.8	−46.5				10	6.4	−40.7				3	7.4	−48.0			
300–309	6	7.0	−35.3	26	7.5	−44.6	4	9.0	−56.5	3	6.7	−31.7	24	7.9	−48.2	6	[illegible]	−51.5	15	8.0	−47.8			
310–319	18	9.1	−47.6	26	9.0	−51.5	14	10.2	−62.0	11	8.5	−43.8	25	9.8	−59.9	8	9.9	−57.9	18	10.0	−60.3			
320–329	22	10.7	−58.3	12	10.4	−59.2	8	10.8	−63.5	22	10.2	−53.1	4	11.4	−67.2	9	10.3	−57.0	21	11.2	−63.7	2	8.2	−27.0
330–339	5	11.5	−59.6	6	11.0	−58.0	3	11.6	−62.0	7	11.6	−59.4	1	12.8	−75.0	3	12.5	−68.7	4	12.0	−66.0	10	10.2	−41.0
340–349	1	12.4	−59.0	2	11.2	−52.5	1	11.8	−56.0	3	11.9	−56.3	1	12.3	−67.0							16	13.5	−66.3
350–359	4	13.1	−63.0	2	13.4	−65.5													2	12.6	−60.0	12	15.0	−77.3
360–369	3	13.3	−58.7				1	13.0	−54.0										2	13.6	−62.0	20	16.4	−85.0
370–379	1	14.2	−62.0				1	13.5	−58.0	1	14.6	−67.1				1	14.2	−61.0				7	17.0	−85.7
380–389	1	15.6	−71.0	4	13.9	−57.8	2	14.3	−58.5	3	14.9	−62.0	1	14.0	−58.0				3	14.6	−62.3	3	17.7	−86.3
390–399	2	15.6	−63.0	1	14.2	−55.0							1	14.8	−61.0				3	15.4	−63.0	1	17.7	−80.0
400–409	3	16.6	−67.3							2	16.2	−63.5										1	18.3	−84.0
Weighted means		10.8	−54.5		9.3	−51.3		10.6	−60.2		10.5	−52.1		8.9	−53.6		10.3	−57.5		10.5	−58.7		14.6	−71.9
Mean potential temperature °A. (weighted)	332.3			319.4			324.0			331.4			311.8			320.4			324.6			455.8	
Number days with observations	26			29			17			25			28			16			28			27		

Information contained in footnotes to table 1 are also applicable to table 4.

WEATHER ON THE NORTH ATLANTIC OCEAN

BY H. C. HUNTER

Atmospheric pressure.—For the greater part of the North Atlantic Ocean that is covered by reports at hand, the pressure averaged less than normal during January 1941. This was especially true of the area around the Azores and thence eastward to the Iberian peninsula; at Horta the pressure averaged 6.0 millibars (0.18 inch) less than normal, largely because of very low readings during the week from the 19th to the 25th. At Lisbon, Portugal, pressure during this week was similarly very low for the locality, and a reading was noted on the 21st of 979 millibars (28.91 inches). This was considerably below the lowest reading reported from Horta.

Over waters close to the coasts of Newfoundland, the Maritime Provinces, and the Atlantic States, the pressure generally averaged a little above normal, while at New Orleans, La., it was decidedly above, the positive departure being 2.7 millibars (0.08 inch).

The extremes of pressure found in available vessel reports were 1037.3 and 969.2 millibars (30.63 and 28.62 inches). The high reading was noted on the American liner *Exmoor*, about 70 miles to southeastward of Sandy Hook, during the forenoon of the 7th. The low mark was recorded by the United States Coast Guard cutter *Hamilton*, at 6 p. m. of the 12th, near 40° N., 60° W.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, January 1941*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Millibars	*Millibars*	*Millibars*		*Millibars*	
Lisbon, Portugal [1]	1,013.6	−5.7	1,028	3	979	21
Horta, Azores	1,015.0	−6.0	1,030	31	994	22
Belle Isle, Newfoundland	1,006.1	+0.6	1,028	12	971	13
Halifax, Nova Scotia	1,013.4	+0.5	1,034	16	977	4
Nantucket	1,017.3	0.0	1,034	7	993	4
Hatteras	1,020.0	+0.4	1,034	21	1,005	4
Turks Island	1,016.8	−1.8	1,020	14	1,010	10
Key West	1,019.0	+0.7	1,028	20	1,010	16
New Orleans	1,021.7	+2.7	1,034	10	1,002	16

[1] For 24 days.

NOTE.—All data based on available observations, departures compiled from best available normals related to times of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—There was apparently less storminess over the North Atlantic than during an average January. During the first 3 and the last 5 days of the month there were, by reports at hand, no notably intense gales.

A brief but intense wind-shift squall, with no marked depression of the barometer, was encountered about 6 p. m. of the 5th at a position in the Gulf of Mexico about 220 miles to southeastward of the mouth of the Mississippi River. The report furnished by the Am. S. S. *Texas* (A. Lartsch, captain; R. J. Jones, observer) follows. The correction to be applied to the barometer readings, which are given as read, is −0.09 inch; hours are ship's time:

The wind was south-southeast, 4, with a moderate sea and light rain, the barometer being 30.02 at 4 p. m. At 5:55 with sky overcast and light rain, the wind veered to north, 3. At 6:05 the wind increased to force 12; the sea was small at the time; barometer read 29.98; the sky was overcast, with lightning and heavy driving rain. At 6:30 a heavy confused sea and northerly swell suddenly appeared and the wind veered to northeast, at a force of 10. Then the wind gradually abated down to force 7 from northeast by 8, sky cloudy; barometer read 30.02; sea heavy confused, and northerly swell. At 10 p. m. sky was partly cloudy; sea rough confused, heavy northerly swell; barometer 30.15; wind had abated from force 7 to force 5 still from northeast.

The most important storm of the month over waters not far from the United States was evident on the morning of the 9th, over the northern Bahamas, though it was of no marked strength as yet. It advanced northeastward, passing near Bermuda, to the northwestward, during the night of the 10th–11th, and had by this time become of marked intensity. The U. S. S. *Bowditch*, close to Bermuda, reported the low reading of its barometer as 28.99 inches (981.7 millibars). There was a considerable increase in force during the 11th and the first part of the 12th, as the LOW proceeded northeastward. The center was east of Cape Breton Island during the forenoon of the 13th, then during the 4 days following it took a more northerly course, with probably some loss in strength, reaching the waters to westward of central Greenland by the 17th. The low reading of the *Hamilton*, early on the evening of the 12th, has already been noted. The *Hamilton* and two other Coast Guard cutters, *Spencer* and *Bibb*, recorded winds of hurricane force in connection with this storm, these and the squall met by the *Texas*, already noted, being the only known instances for the month of force-12 winds over North Atlantic waters.

Among the vessels which were much battered by encountering this storm, the American steamships *West Kebar* and *Otho* may be mentioned. The former had a motor launch smashed and suffered considerable structural damage but presently made port in Boston. The *Otho* was hove to for 3 days, then duly arrived in New York harbor; but about 900 tons of palm oil had been jettisoned, and there was 23 feet of water in No. 1 hold. Captain Smith of the *Otho* considered this the worst storm he had ever met during long experience at sea.

The American liner *Santa Rosa* arrived in Bermuda from New York showing considerable damage, especially to lifeboats; this arrival was 2 days later than scheduled, but part of the delay was apparently due to her turning back to stand by the injured *West Kebar* until a cutter could reach that vessel.

A storm of marked energy for the part of the ocean affected was centered on the morning of the 19th to northeastward of the Azores, and entered the northwestern part of the Iberian peninsula on the 20th. The American liner *Exeter* encountered whole-gale winds connected with this storm.

Another LOW of considerable strength crossed the coast of Virginia late on the 24th and traveled toward the east-northeast until southeast of Newfoundland late on the 26th. Two vessels reported whole gales as experienced while within the area affected by this storm.

Fog.—In general, fog was noted more times during January than during the preceding December, particularly near the American coast from New Jersey to the Carolinas.

The 5° square, 35° to 40° N., 70° to 75° W., reported fog on 10 days, leading all other North Atlantic squares. In the northwestern Gulf of Mexico the square 25° to 30° N., 90° to 95° W., noted fog on 5 days, all but one of them after the 22d.

Near Miami fog was seen on the 7th and a short distance to eastward of Key West was observed on the 25th.

While most squares to eastward of the 60th meridian are not known to have had any fog during the month, the square 35° to 40° N., 45° to 50° W., furnishes reports of fog on 4 days, all within the final fortnight.

OCEAN GALES AND STORMS, JANUARY 1941

Vessel	Voyage		Position at time of lowest barometer		Gale began January	Time of lowest barometer January	Gale ended January	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Millibars*					
Standard, Pan. S. S.	New York	Caripito	34 54 N.	72 15 W.	3	10p, 3	4	1,002.7	W	W, 9	NW	W, 9	W-N.
Mormaclark, Am. M. S.	Montevideo	New York	31 30 N.	61 50 W.	5	9a, 4	6	1,006.8	W	SW, 6	WNW	WNW, 8	
Spencer, U. S. C. G.	On Station No. 1.		38 45 N.	58 50 W.	4	3p, 4	7	992.9	SE	SSW, 10	NNW	W, 11	SE-WSW.
Texas, Am. S. S.	Baltimore	Port Arthur	26 36 N.	87 00 W.	5	6p, 5	5	1,012.2	N	N, 11	NE	NNE, 12	W-N-NE.
Bibb, U. S. C. G.	On Station No. 2.		38 30 N.	45 54 W.	5	2p, 6	7	999.0	SSE	SW, 7	N	S, 10	SW-W.
Aldecoa, Span. S. S.	Cabedello, Brazil.	Gibraltar	33 09 N.	10 01 W.	9	12m, 10	10	1,005.7	SW	WNW, 8	WNW	W, 8	W-WNW.
Coamo, Am. S. S.	New York	San Juan	32 16 N.	71 30 W.	10	12p, 10	12	994.9	NE	NNW, 6	WNW	NW, 9	NE-NNW.
Medea, Du. S. S.	do	Puerto Sucre	31 10 N.	70 42 W.	11	1a, 11	11	988.2	NNW	NNW, 8	WNW	WNW, 9	NNW-NW.
Gulfpenn, Am. S. S.	Providence	Puerto La Cruz Venezuela.	35 40 N.	70 30 W.	10	12m, 11	12	985.8	ENE	NNW, 9	NW	NW, 9	NNE-NW.
Alaskan, Am. S. S.	San Juan	Jacksonville	28 23 N.	77 41 W.	10	12m, 11	12	1,012.9	NW	NW, 8	NNW	NW, 8	None.
San Miguel, Port. S. S.	Ponta Delgada	New York	37 06 N.	67 48 W.	11	2p, 11	12	978.7	NE	NNE, 8	NNW	NNE, 8	NE-NNE.
Angelina, Am. S. S.	San Juan	do	28 00 N.	68 54 W.	12	2p, 11	12	1,002.7		WNW, 7	NW	NW, 8	
Otho, Am. S. S.	Freetown	do	[1]33 59 N.	66 14 W.	11	4p, 11	14	972.2	NW	SW, 6	NW	NW, 9	SW-W.
Oremar, Am. S. S.	Cristobal	Philadelphia	30 12 N.	74 30 W.	10	4p, 11	12	999.0	NW	NW, 8	NW	NW, 10	NW-N.
San Blas, Pan. S. S.	Puerto Cortes	Baltimore	33 25 N.	76 16 W.	11	4p, 11	12	1,009.5	NNW	NNW, 7	N	N, 9	Steady.
Santa Rosa, Am. S. S.	New York	Bermuda	37 00 N.	70 30 W.	11	5p, 11	13	990.9	NNE	NNE, 9	WNW	N, 10	NNE-N.
Gulfhawk, Am. M. S.	do	Las Piedras	34 54 N.	72 06 W.	11	7p, 11	12	997.3	NNE	NNW, 11	NW	NNW, 11	N-NNW.
Spencer, U. S. C. G.	Station No. 1	New York	39 28 N.	68 15 W.	11	8p, 11	12	987.5	NE	N, 11	NNW	N, 12	NNE-N.
Uruguay, Am. S. S.	New York	Barbados	[1]35 31 N.	70 38 W.	11	8p, 11	13	991.9	N	N, 10	WSW	N, 10	NNE-N.
Mayari, Pan. S. S.	Boston	Banes, Cuba	38 40 N.	70 38 W.	11	8p, 11	13	999.0	NE	NNE, 10	WNW	NNE, 10	NE-N.
Excalibur, Am. S. S.	Bermuda	New York	[1]34 38 N.	66 47 W.	11	10p, 11	13	972.9	SSW	NNW, 10	NW	SW, 10	W-NNW.
Examiner, Am. S. S.	Trinidad	do	24 40 N.	69 20 W.	10	11p, 11	12	1,008.5	WSW	W, 9	NW	WNW, 9	NW-W-WNW.
Alcoa Scout, Am. S. S.	New York	Bermuda	[1]34 23 N.	64 21 W.	10	4a, 12	14	970.9	E	WNW, 8	WNW	SW, 10	W-NW.
Exeter, Am. S. S.	do	do	36 57 N.	69 35 W.	11	8a, 12	12	994.2	NE	N, 9	NW	N, 9	NNE-NNW.
Bibb, U. S. C. G.	Station No. 2	Norfolk	[1]37 00 N.	57 06 W.	11	4p, 12	14	978.0	E	S, 10	WNW	ESE, 12	SE-SSW.
Hamilton, U. S. C. G.	Norfolk	Station No. 1	39 42 N.	60 12 W.	10	6p, 12	15	969.2	SSE	NE, 8	NW	ESE, 12	ESE-N.
Siboney, Am. S. S.	Bermuda	Lisbon	38 42 N.	10 00 W.	13	6p, 14	14	999.3	NNE	N, 6	NNE	NNE, 9	NNE-N.
Hamilton, U. S. C. G.	On Station No. 1.		39 45 N.	58 43 W.	17	3p, 17	17	1,010.8	S	SSW, 9	SW	SSW, 10	S-SW.
Agwistar, Am. S. S.	New York	Vera Cruz	21 36 N.	91 00 W.	18	6p, 17	18	1,010.5	N	E, 2	NNW	NNW, 9	NE-E-W.
Siboney, Am. S. S.	Lisbon	Bermuda	38 00 N.	24 18 W.	18	4a, 20	20	988.8	WSW	WNW, 8	NNW	WSW, 9	W-WNW.
Hamilton, U. S. C. G.	On Station No. 1.		38 48 N.	59 18 W.	20	1p, 20	22	998.3	NW	WNW, 10	NW	WNW, 10	
Exeter, Am. S. S.	Bermuda	Lisbon	38 46 N.	14 00 W.	21	5p, 20	21	980.7	W	WSW, 5	WNW	WNW, 10	
Ingham, U. S. C. G.	On Station No. 2.		38 24 N.	45 36 W.	20	10p, 20	23	997.0	SW	W, 4	NW	WNW, 9	SW-W.
Hamilton, U. S. C. G.	On Station No. 1.		38 36 N.	60 00 W.	23	2a, 24	24	1,015.6	WSW	W, 8	NNW	NW, 9	WSW-NW.
Massachusetts, Am. S. S.	Port Arthur	Providence	40 54 N.	71 30 W.	24	1a, 25	25	1,006.4	SE	E, 8	N	E, 10	SE-NE.
Hamilton, U. S. C. G.	On Station No. 1.		39 00 N.	58 06 W.	25	3a, 26	26	997.6	SSW	W, 8	NW	WNW, 10	WSW-WNW.
NORTH PACIFIC OCEAN													
California Standard, Pan. M. S.	Yokohama	San Francisco	42 42 N.	169 54 W.	1	12p, 2	3	989.8	SE	SE, 8	SW	SE, 8	SE-SW.
Meigs, U. S. A. T.	Manila	do	39 35 N.	175 30 E.	1	5a, 2	2	989.2	S	SW, 6	W	S, 9	SW-WSW.
Aurora, Am. M. S.	Vladivostok	Los Angeles	48 48 N.	177 06 E.	2	12p, 2	2	981.7	ESE	SE, 5	ESE	ESE, 9	ESE-S.
Ecuador, Swed. M. S.	Los Angeles	Vladivostok	38 43 N.	174 25 E.	2	12m, 2	4	991.4	S	W, 8	WNW	WNW, 10	SSW-W.
District of Columbia, Am. S. S.	Portland, Oreg.	San Francisco	41 54 N.	124 42 W.	4	9p, 4	4	1,005.1	S	S, 8	SW	S, 8	SSE-W.
Ecuador, Swed. M. S.	Los Angeles	Vladivostok	[1]38 35 N.	161 59 E.	5	4a, 5	6	998.1	W	W, 5	WNW	W, 10	SSW-W.
Meigs, U. S. A. T.	Manila	San Francisco	40 18 N.	156 30 W.	6	2a, 6	7	999.7	WNW	W, 5	NW	WNW, 9	
St. Mihiel, U. S. A. T.	Seward	do	47 35 N.	132 38 W.	6	12p, 6	6	977.0	E	SE	ESE	E, 8	ESE-SSE.
Bralanta, Nor. M. S.	Yokohama	Los Angeles	40 15 N.	171 11 W.	6	2a, 7	7	989.8	SSW	SW, 7	SSW	SSW, 10	SSW-SW.
Mapele, Am. S. S.	San Francisco	Honolulu	33 00 N.	136 06 W.	6	6a, 7	8	995.9	W	W, 8	NW	N, 9	WSW-W.
Satartia, Am. S. S.	Legaspi, P. I.	Los Angeles	33 25 N.	157 27 E.	6	1a, 7	8	1,006.8	NW	NW, 9	NW	NW, 10	
Illinois, Am. S. S.	Yokohama	San Francisco	40 18 N.	178 30 E.	7	2p, 7	8	972.9	SSE	SSW, 10	WNW	SSW, 10	SSE-WSW.
Maunawili, Am. S. S.	Honolulu	do	30 29 N.	141 53 W.	7	2p, 7	7	1,009.8	NW	NW, 9	NNW	NW, 9	None.
Makua, Am. S. S.	Los Angeles	Honolulu	31 30 N.	130 30 W.	7	6p, 7	8	992.9	SSW	SSW, 8	NW	NNW, 9	SSW-WNW.
District of Columbia, Am. S. S.	San Francisco	Balboa	34 33 N.	120 42 W.	8	9p, 8	8	1,009.1	SE	SE, 8	SE	SE, 8	
Brunswick, Pan. M. S.	Los Angeles	Yokohama	34 36 N.	141 42 E.	8	12m, 8	8	1,008.1	ENE	NE, 9	NE	NE, 9	E-NNE.
Bralanta, Nor. M. S.	Yokohama	Los Angeles	40 45 N.	161 51 W.	7	4p, 8	9	976.3	SW	SW, 11	WSW	SW, 11	SW-WSW.
Hamakua, Am. S. S.	Balboa	San Diego	15 48 N.	94 06 W.	8	6p, 8	9	1,010.5	WNW	NNW, 5	NE	NNW, 8	NNW-WNW-NW.
Maunalei, Am. S. S.	San Francisco	Honolulu	37 36 N.	123 06 W.	8	10p, 8	9	1,010.5	SE	SE, 6	E	ESE, 8	SE-ESE.
Mapele, Am. S. S.	do	do	27 35 N.	145 17 W.	9	12m, 10	10	1,009.1	SW	S, 8	W	S, 8	S-NW.
Nebraskan, Am. S. S.	Los Angeles	Balboa	9 40 N.	89 20 W.	11	2a, 11	11	1,011.2	NNE	NNE, 6	NNE	NE, 8	None.
Steel Navigator, Am. S. S.	Balboa	Los Angeles	15 54 N.	97 36 W.	10	5a, 11	10	1,011.9	N	W, 3	NE	NNE, 8	NE-W.
Satartia, Am. S. S.	Legaspi, P. I.	do	35 12 N.	178 24 E.	10	12m, 11	11	1,006.4	SE	SE, 10	S	SE, 10	SE-S.
Virginian, Am. S. S.	Balboa	do	15 23 N.	94 03 W.	11	4p, 11	12	1,011.2	NNE	N, 6	ENE	N, 8	NNE-N.
Taketoyo Maru, Jap. S. S.	Yokohama	San Francisco	46 54 N.	175 18 W.	12	4a, 12	13	983.6	WNW	SSW, 3	WNW	WNW, 10	SSW-WNW.
Vermont, Am. S. S.	Los Angeles	Balboa	10 40 N.	87 35 W.	10	4p, 12	13	1,010.8	E	NE, 8	NE	NE, 9	None.
Makiki, Am. S. S.	Seattle	Honolulu	42 08 N.	135 35 W.	14	9a, 14	14	1,000.7	WSW	WSW, 8	WNW	W, 10	WSW-WNW.
Satartia, Am. S. S.	Legaspi, P. I.	Los Angeles	34 54 N.	141 54 W.	17	2a, 18	18	1,005.4	WSW	SW, 8	SW, 8	WNW, 9	SW-WNW.
West Kyska, Am. S. S.	San Francisco	Seattle	[1]44 45 N.	125 02 W.	18	8a, 19	18	1,013.2	SE	NE, 6	SE	SE, 8	
U. S. S. Nitro	Balboa	San Diego	13 30 N.	94 36 W.	18	6p, 18	19	1,011.9	NNW	NNW, 6	NE	NE, 9	
Makiki, Am. S. S.	Seattle	Honolulu	35 00 N.	141 05 W.	17	2a, 18	18	1,003.7	WSW	SW, 10	WNW	WSW, 12	SSW-WSW.
Pleasantville, Nor. M. S.	Manila	Los Angeles	38 36 N.	171 12 E.	14	12p, 14	16	997.7	W	W, 8	NW	NNW, 9	W-NW.
Admiral Halstead, Am. S. S.	Lalawigan, P. I.	do	33 24 N.	178 30 W.	20	12p, 19	20	979.7	SSE	SW, 7	WNW	NNW, 12	SW-NNW.
Vermar, Am. S. S.	Los Angeles	Balboa	15 30 N.	95 48 W.	20	3p, 20	21	1,010.8	ENE	ENE, 5	NW	NNE, 9	ENE-NNE.
Daini Ogura Maru, Jap. M. S.	Yokohama	Los Angeles	37 54 N.	169 30 W.	20	12p, 20	21	974.6	N	E, 6	W	NW, 9	E-N.
Noto Maru, Jap. M. S.	do	San Francisco	36 54 N.	178 18 E.	20	12p, 23	23	977.3	S	W, 7	W	WNW, 10	W-WNW.

[1] Position approximate.

OCEAN GALES AND STORMS, JANUARY 1941—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began January	Time of lowest barometer January	Gale ended January	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH PACIFIC OCEAN—Con.			° ′	° ′				Millibars					
President Van Buren, Am. S. S.	Hong Kong	San Francisco	38 12 N.	179 16 E.	22	4a, 23	22	982.7	SE	W, 6	SE	SE, 8	WNW-WSW-WNW.
Emidio, Am. S. S.	Shanghai	Los Angeles	41 16 N.	179 20 W.	22	12m, 22	22	972.2	SE	S, 6	SSE	E, 8	NE-S-SW.
President Van Buren, Am. S. S.	Hong Kong	San Francisco	37 54 N.	158 24 W.	25	1p, 25	25	973.6	SE	SSW, 8	SW	SW, 9	SE-WSW.
Noto Maru, Jap. M. S.	Yokohama	do	38 10 N.	164 21 W.	25	12m, 25	26	962.1	SW	SW, 8	W	W, 11	SW-WSW.
Emidio, Am. S. S.	Shanghai	Los Angeles	[1] 42 20 N.	163 00 W.	25	6p, 25	26	960.0	ENE	NNW, 9	W	N, 10	NNE-NNW.
Coldbrook, Am. S. S.	Kobe	Vancouver, B. C.	50 30 N.	155 34 W.	25	8a, 26	27	964.4	NE	NNW, 8	SSW	NNE, 9	None.
Chirikof, U. S. A. T.	Seward	Ketchikan	58 36 N.	147 30 W.	27	8a, 27	28	967.5	NE	SSE, 6	SSE	SSE, 8	NE-S.
Emidio, Am. S. S.	Shanghai	Los Angeles	41 50 N.	151 00 W.	27	3a, 28	28	982.7	S	S, 10	SSW	SSE, 10	SSE-SW.
Coldbrook, Am. S. S.	Kobe	Vancouver, B. C.	50 10 N.	143 27 W.	28	4p, 28	29	982.1	SSE	SE, 10	W	SE, 10	SSE-SE-S.
Texmar, Am. S. S.	Balboa	Los Angeles	9 15 N.	85 54 W.	30	4p, 30	31	1,007.8	NNE	NNE, 6	NE	NNE, 8	
Coldbrook, Am. S. S.	Kobe	Vancouver, B. C.	49 11 N.	126 48 W.	30	5a, 31	31	997.3	SE	ESE, 9	SE	E, 10	E-S.
Swiftsure Bank Lightship, U. S.	On station		48 33 N.	125 00 W.	30	6a, 30	30	1,002.7	SE	SE, 9	S	SE, 10	SE-S.
Swiftsure Bank Lightship, U. S.	do		48 33 N.	125 00 W.	31	8a, 31	[2] 1	1,003.7	E	E, 7	SE	SE, 10	E-SE.

[1] Position approximate.

[2] February.

WEATHER ON THE NORTH PACIFIC OCEAN

By WILLIS E. HURD

Atmospheric pressure.—Owing to the prevalence of numerous cyclonic depressions on northern and middle waters of the North Pacific Ocean during January 1941, the average barometer was below normal at all coastal and island stations shown in table 1, except in the extreme southwest, where pressures were normal or slightly above. The greatest departures occurred in the Aleutian region, with the maximum at Dutch Harbor, where the average pressure, 993.5 millibars (29.34 inches), was 8.2 millibars (0.24 inch) below the normal. The lowest station pressure reading was 963 millibars (28.44 inches), at Kodiak, on the 27th. The lowest reported ship's barometer was 960 millibars (28.35 inches), read on the American S. S. *Emidio*, near 42° N., 163° W., 25th. Nearly as low a reading, 961 millibars (28.38 inches), was made on the Japanese S. S. *Norfolk Maru*, near 47° N., 164° W., on the 8th.

Regions of moderately high average pressure lay off the coasts of California and eastern China.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean January 1941, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Millibars	Millibars	Millibars		Millibars	
Barrow	1,018.5	−0.1	1,042	21	985	30
Dutch Harbor	993.5	−8.2	1,012	11	976	8
St. Paul	999.6	−3.8	1,014	25	983	28
Kodiak	995.1	−4.9	1,019	21	963	27
Juneau	1,006.8	−5.1	1,025	23	985	27
Tatoosh Island	1,012.5	−2.8	1,028	1	992	24
San Francisco	1,017.3	−2.3	1,027	17	1,004	6
Mazatlan	1,014.0	−0.2	1,016	9, 12, 23	1,011	27
Honolulu	1,015.6	−0.3	1,021	5	1,010	27
Midway Island	1,015.0	−1.9	1,028	1	1,001	22
Guam	1,012.4	−0.1	1,016	13	1,010	16, 18
Manila	1,013.3	+1.1	1,018	15	1,010	18, 24
Hong Kong	1,017.3	−2.3	1,030	31	1,008	22
Naha	1,019.0	+0.4	1,03 1	31	1,011	22, 23
Titijima	1,016.3	0.0	1,024	27	1,009	8
Petropavlovsk	1,002.5	−1.6	1,027	23	974	16

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observations.

Extratropical cyclones and gales.—January 1941 was less severely stormy than the preceding December in northern and eastern waters, but was much more stormy in mid-ocean, especially between latitudes 30° and 40° N., longitudes 160° W., and 170° E., where gales were few and moderate in December. Stormy conditions were for the most part local during the first 5 days of the month, but on the 6th to 12th they became more widespread, as well as again on about the 18th to 25th. Some 15 reports from ships showed gales of force 10 as observed on 12 days. Four reports gave winds encountered as high as force 11 to 12, but these velocities appear to have been more in the form of sharp squalls than of sustained high winds.

From January 1 to 5 few gales were encountered on the Pacific, and those were mostly in connection with moderately stormy conditions in middle longitudes. The exception was a south gale of force 8 reported off the lower coast of Oregon on the 4th. The highest wind was of force 10, encountered on the 3d, near 39° N., 174° E., in the midst of stormy weather in which one vessel was involved from the 2d to the 6th. On the 5th this ship came under the influence of another LOW and encountered a further gale near 39° N., 162° E. By the 6th this LOW going eastward, had deepened, and in conjunction with another deep cyclone center to the eastward of the 180th meridian, was causing fresh to whole gales at various points between longitudes 160° E. and 155° W., along the middle and northern routes. By the 7th the western and more important cyclone was central near 42° N., 175° E., moving rapidly northeastward toward the eastern Aleutians, near which it was central on the 8th, accompanied by low pressures and scattered gales, the strongest of which, of force 11, was reported near 41° N., 162° W., on the 8th.

Meanwhile, another disturbance, of less extent, had developed on the 7th some 600 miles off the central California coast. To the westward of the center and about midway of the route toward Honolulu, the wind in localities had risen to force 9 from northerly directions. By the 8th the disturbance had moved southeastward to near 33° N., and 125° W., still causing high winds to the westward of the center, and also to the eastward near

Point Arguello. On the 9th it had moved slowly northwestward, lessening in energy, but ere its disintegration had given rise to a southeasterly gale of force 8 close in off the coast north of San Francisco.

On the 17th to 19th, in nearly the same region, stormy weather again occurred, in the lower quadrants of an elongated low pressure area with center in the Gulf of Alaska. During the 18th, which was the stormiest day, southeasterly gales occurred along the northern California coast, and gales of higher intensity were reported about midway between California and the Hawaiian Islands. The strongest winds, occurring in fierce morning squalls of hurricane force, were encountered by the American S. S. *Makiki* near 35° N., 141° W.

From the 11th to 15th, near midocean, cyclonic conditions were prevalent, and scattered gales of force 9 to 10 were reported daily from localities to the northward of about the 35th parallel, between about longitudes 175° W. and 170° E.

On the 19th and 20th the American S. S. *Admiral Halstead*, east-bound from the Philippines, ran into stormy weather to the northward of Midway Island. Near 33° N., 178° W., on the 19th, her barometer had fallen below 982 millibars (29 inches), and early on the following day she rode through northwesterly squalls of hurricane force.

From the 21st to 25th, while a succession of LOW centers appeared over a great extent of middle longitudes, ships reported gales in many localities, the positions of which may best be visualized by reference to the table of gales and storms. Among the ships experiencing the greatest stress of weather during this period may be mentioned the Japanese M. S. *Noto Maru*, Yokohama to San Francisco. This ship entered the gale region on the 20th not far from 37° N., 160° E. On the 22d, near 170° E., the wind force had increased to 10. On the 23d and 24th the winds on ship were of less intensity, but on the 25th, near 38° N., 164° W., with a low barometer of 962.1 millibars (28.41 inches), they had risen to their highest velocity, force 11. A special report on the storm by Third Officer H. S. Littlefair, of the American S. S. *President Van Buren*, Hong Kong to San Francisco, told of similar weather from the 22d to 25th, culminating in the heaviest gales, force 9 to 10, near 38° N., 157° W., on the 25th. It was in this storm, on the 25th, that the American S. S. *Emidio* had the lowest barometer of the month, with northerly gales of force 9–10, near 42° N., 163° W.

During the 28th a deep cyclone covered a great extent of the northeastern part of the ocean, centered at about 45° to 50° N., 155° to 165° W. During the day two vessels reported southeasterly gales of force 8 in the Gulf of Alaska, and two reported southeasterly gales of force 10 much farther southward, one near 50° N., 143° W., and the other near 42° N., 151° W. The storm went rapidly northeastward during the 29th.

Swiftsure Bank Lightship reported gales of force 8 on the 14th to 17th and on the 24th, and of force 10 on the 30th and 31st.

Tehuantepecers and Papagayos.—Owing to the southward extension of anticyclones into the Gulf of Mexico on several days of the month, an unusual number of "overflow northers" entered Pacific waters, resulting in gales, for the most part from the northeast, not only in the Gulf of Tehuantepec, but also west of Costa Rica, where they are known as Papagayos. The Tehuantepecers occurred as follows: of force 7 on the 12th; of force 8 on the 8th to 11th; of force 9 on the 18th to 20th. The Papagayos were observed as follows: of force 7 on the 10th and 20th; of force 8 on the 11th and 30th; of force 9 on the 12th.

Fog.—Very little fog was reported. It was observed on 3 days at the entrance to the Strait of Juan de Fuca; on 1 day off the Oregon coast; and on 1 day near 34° N., 146° W.

RIVER STAGES AND FLOODS

By BENNETT SWENSON

Precipitation during January 1941 was above normal in the upper half of the Mississippi, the middle and lower Missouri, the upper and middle Arkansas, the Rio Grande, the Gila and the Sacramento River basins; elsewhere the precipitation was generally below normal. Snow depths at the end of the month were below normal except in the following areas: Portions of the northeast with depths of 10 to over 30 inches, the extreme upper Mississippi Basin with more than 15 inches in northern Wisconsin and Minnesota, and portions of the Rocky and Sierras Mountain regions.

The temperature was above the average for the month over the country except in the extreme northeast. This was the second consecutive month of mild weather this winter.

The excessive rainfall resulted mainly in light to moderate floods at isolated points as follows:

Atlantic Slope drainage.—No floods of any consequence occurred in this area. The Santee River reached flood stage at Rimini and Ferguson, S. C., from January 2 to 5. The rise was due mainly to dam-water release. Flood stage was also reached in the Savannah River at Clyo, Ga., on January 12.

East Gulf of Mexico drainage.—A slight rise occurred in the Tombigbee River on January 6 but no overflow occurred. Flooding continued in the Pearl River Basin from December; at Pearl River, La., the stage fell below the flood level on January 12. The total losses, most of which occurred in December, were estimated at $10,200. Warnings were issued well in advance in most instances and money value of property saved by flood warnings totalling $6,700 has been reported.

Mississippi System.—Heavy rains in portions of Kansas brought the stages in the Osage and lower Neosho Rivers close to bankful from the 17–19, but no overflow occurred, except for a slight overflow in the Osage at La Cygne, Kans., where a crest of 25.5 feet (0.5 foot above flood stage) was reached on the 19th.

The Sulphur River in Texas was in flood at the beginning of the month, continuing until the 6th at Naples, Tex. Another rise near the end of the month resulted in a slight overflow at Ringo Crossing, Tex., on the 24th. Damages amounting to $2,500 were reported.

West Gulf of Mexico drainage.—In the Trinity River at Trinidad, Tex., the stage was above flood stage from December 17 to January 10, the highest stage being 36.5 feet on December 24. High water continued in the lower Trinity River during November, December, and most of January, being above flood stage much of this time.

Some flooding occurred also in the Sabine and Guadalupe Rivers.

Pacific Slope drainage.—The Sacramento River again experienced flood stages in January but were slightly lower than in December. The waters of the previous flood had only partially receded when the rise of this month began,

so that much of the affected lowlands continued under water since December, such as the island tracts of Liberty and Prospect in the Yolo Bypass. The ultimate losses in these areas will depend on how soon the waters permanently recede so that crops may develop.

Estimated flood losses and savings, January 1941

River and basin	Tangible property	Matured crops	Livestock and other movable farm property	Suspension of business	Savings
East Gulf of Mexico					
Pearl River [1]		$100	$3,100	$7,000	$6,700
West Gulf of Mexico					
Sulphur River	$200		300	2,000	5,000

[1] December and January.

FLOOD-STAGE REPORT JANUARY 1941

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
	Feet			*Feet*	
James: Columbia, Va	10	(1)	1		
Santee:					
Rimini, S. C	12	2	5	12.6	3
Ferguson, S. C	12	4	5	12.0	5
Savannah: Clyo, Ga	11	7	14	11.5	12
EAST GULF OF MEXICO DRAINAGE					
Pearl:					
Jackson, Miss	18	(1)	6		
Monticello, Miss	15	(1)	1		
Columbia, Miss	17	(1)	1		
Pearl River, La	12	(1)	12	15.1	2

[1] Continued from previous month.

FLOOD-STAGE REPORT JANUARY 1941—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM					
Missouri Basin					
	Feet			*Feet*	
Osage: La Cygne, Kans	25	19	19	25.5	19
Arkansas Basin					
Petit Jean: Danville, Ark	20	2	5	22.1	4
Red Basin					
Sulphur:					
Ringo Crossing, Tex	20	(1)	1		
		24	27	22.0	24
Naples, Tex	22	(1)	7	27.4	1
Lower Mississippi Basin					
Coldwater: Coldwater, Miss	13	2	5	14.0	4
		27	29	13.4	28
WEST GULF OF MEXICO DRAINAGE					
Sabine:					
Logansport, La	25	(1)	20	31.9	4
Bon Wier, Tex	21	(1)	2	21.2	1
Trinity:					
Trinidad, Tex	28	(1)	10	34.0	5
Long Lake, Tex	40	(1)	6	41.7	Dec. 31,1
Liberty, Tex	24	(1)	24	26.1	1
Guadalupe: Victoria, Tex	21	15	17	25.2	17
PACIFIC SLOPE DRAINAGE					
Sacramento Basin					
Sacramento:					
Red Bluff, Calif	23	26	26	24.4	26
Knights Landing, Calif	30	26	30	30.6	27
Columbia Basin					
Long Tom: Monroe, Oreg	10	18	22	11.7	20–21
		27	28	10.0	27–28

[1] Continued from previous month.

CLIMATOLOGICAL DATA

CONDENSED CLIMATOLOGICAL SUMMARY OF TEMPERATURE AND PRECIPITATION BY SECTIONS

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	48.1	+1.6	Geneva	79	24	2 stations	17	1 6	2.74	−2.10	Frisco City	5.32	Elba	0.87
Arizona	43.3	+1.4	3 stations	78	1 9	Alpine	−7	3	1.86	+.56	Pinal Ranch	6.78	Sells	.28
Arkansas	43.6	+2.4	Boonville	76	1	Gravette	5	19	3.43	−.97	Lutherville	6.69	Index	1.95
California	46.7	+2.0	Cow Creek	80	28	2 stations	−6	1 3	6.05	+1.19	Upper Mattole	29.12	Brawley	.55
Colorado	25.5	+1.6	Trinidad	69	11	Taylor Park	−43	3	1.04	+.26	Cumbres	4.61	Kauffman (near)	T
Florida	57.7	−1.3	Fellsmere	89	1	2 stations	22	1 20	3.44	+.68	St. Leo	7.15	Key West Airport	1.00
Georgia	47.4	+.5	Albany	79	13	Blairsville	11	6	1.85	−2.37	Clayton	4.03	Savannah Airport	.44
Idaho	27.4	+2.3	Winchester	57	10	2 stations	−30	1 2	1.62	−.55	Deception Creek	5.37	Oakley	.17
Illinois	30.9	+3.2	Cairo	63	14	do	−8	19	2.50	+.11	Barry	4.18	Palestine	.88
Indiana	30.8	+1.8	Shoals	63	1	Wheatfield	−3	19	1.66	−1.45	Cypress	2.77	Anderson	.71
Iowa	23.8	+5.3	Missouri Valley	59	11	6 stations	−8	1 18	1.73	+.63	Donnellson	3.44	Primghar	.35
Kansas	33.3	+3.5	Richfield	70	11	Alton	−7	24	1.99	+1.29	Kansas City (sub)	6.16	Smith Center	.34
Kentucky	36.7	+.9	2 stations	66	1 1	Lynch (near)	0	6	2.53	−1.96	Burnside	3.51	Jenkins	1.19
Louisiana	53.3	+1.6	Baton Rouge	83	2	Plain Dealing	19	19	3.54	−1.34	Jennings	5.64	Calhoun	1.66
Maryland-Delaware	32.3	−.9	2 stations	62	23	Oakland, Md	−10	21	3.05	−.32	Milford, Del	4.81	Chewsville, Md	2.14
Michigan	22.1	+1.2	Holland	52	2	Mio	−29	24	1.80	−.09	Detour	5.28	Grand Marais	.72
Minnesota	13.5	+4.2	Redby	47	31	Warroad	−38	23	.92	+.16	Pigeon River Bridge	6.41	Tracy	.21
Mississippi	48.7	+1.4	2 stations	79	1 23	Rochdale	14	19	2.79	−2.32	Poplarville	4.88	Belzoni	1.35
Missouri	34.7	+4.0	3 stations	70	1 11	4 stations	0	1 18	3.41	+1.00	Lawson	5.74	Belleview	.93
Montana	24.3	+4.7	Grass Range	70	28	Wisdom	−28	2	.46	−.47	Heron	3.10	3 stations	T
Nebraska	26.8	+3.0	2 stations	65	1 10	Arthur	−22	5	.98	+.45	Auburn	2.72	2 stations	.15
Nevada	34.6	+5.0	Overton	75	22	Ventosa	−14	3	1.10	−.10	Marlette Lake	5.70	do	.00
New England	19.3	−3.2	2 stations	51	23	First Connecticut Lake, N. H.	−30	27	2.47	−.99	Provincetown, Mass.	6.11	Rochester, Vt	.77
New Jersey	29.4	−1.5	Pleasantville	58	23	Layton	−7	30	3.47	−.18	Long Branch	5.29	Paterson	2.08
New Mexico	34.1	+.6	4 stations	70	1 18	Eagle Nest	−30	4	1.15	+.56	White Tail	3.98	2 stations	T
New York	21.3	−1.8	Cairo	51	5	Stillwater Reservoir	−34	14	2.08	−.85	Bridgehampton	4.14	Massena	.91
North Carolina	40.8	−.7	Albemarle	77	15	2 stations	1	1 5	2.04	−1.71	Andrews	4.56	Gastonia	.96
North Dakota	11.0	+4.7	New England	53	1 29	do	−33	1 18	.54	+.06	Courtenay	1.62	2 stations	.05
Ohio	29.8	+1.4	Athens	63	2	Bellefontaine	0	5	1.97	−1.10	Cherry Fork	3.39	Kenton	.91
Oklahoma	41.8	+3.6	Antlers	76	1	Grove	7	19	2.03	+.58	Sallisaw	6.32	Goodwell	.30
Oregon	35.1	+3.2	Port Orford	75	11	Chemult	−11	1	3.52	−.29	Valsetz	17.50	Enterprise	.28
Pennsylvania	27.9	−.5	2 stations	58	2	Coudersport	−10	14	2.62	−.61	Mount Pocono	4.15	Millville	1.11
South Carolina	45.1	−.7	7 stations	74	1 1	2 stations	14	6	1.74	−1.81	Jocassee (near)	3.81	Santuck	.95
South Dakota	19.5	+2.8	Faith	68	11	do	−23	18	.49	−.06	Watertown	1.45	2 stations	T
Tennessee	40.1	+1.0	Etowah	75	23	Erwin	7	6	2.60	−2.25	Sewanee	4.64	Elizabethton	1.35
Texas	50.4	+2.2	Mission	88	25	Muleshoe	9	1 18	1.75	+.06	Harlingen	9.17	Hereford	.03
Utah	27.1	+1.9	St. George	64	9	Woodruff	−30	1	1.20	−.03	Timpanogos Summit	3.78	Milford	.10
Virginia	35.6	−.8	Diamond Springs	71	23	Burkes Garden	1	6	2.20	−1.09	Onley	4.00	2 stations	1.16
Washington	35.1	+4.7	South Bend (near)	65	10	Stockdill Ranch	−10	1 2	3.96	−1.09	Cushman Dam	17.11	Sequim	.55
West Virginia	32.5	−.1	Parsons	66	2	Terra Alta	−6	21	2.73	−.90	Pickens	6.27	Brandywine	1.07
Wisconsin	19.1	+4.0	3 stations	45	1 12	2 stations	−25	1 5	1.41	+.16	Beloit	3.34	Ladysmith	.37
Wyoming	22.3	+2.4	Fort Phil Kearny	70	28	Moran	−35	1 2	.49	−.30	Bechler River	5.76	Powell	T
Alaska (December)	11.2	+6.2	3 stations	58	7	Allakaket	−69	17	2.57	−.10	Latouche	24.30	Nenana	.03
Hawaii	70.1	+1.9	do	89	1 4	Haleakala (Maui)	29	1 13	4.55		Kawainui	27.24	Puako	.00
Puerto Rico	73.1	+.4	2 stations	94	1 2	2 stations	51	1 9	3.41	−.45	LaMina	8.58	Ensenada	.50

[1] Other dates also.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F*		*°F*	*°F.*		*°F*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							**21.1**	**−2.3**										**76**	**2.63**	**−0.8**										**6.2**		
Eastport	75	67	85	29.92	30.02	+0.02	19.0	−1.4	40	23	25	−5	14	13	30	17	12	74	1.21	−2.7	11	13.6	nw.	34	e.	4	8	7	16	6.2	9.9	2.5
Greenville, Maine	1,070	6	----	28.86	30.09	----	9.6	----	33	23	18	−16	28	−1	34	8	6	----	2.38	----	10	----	----	----	----	----	----	----	----	----	----	20.0
Portland, Maine [2]	103	82	117	29.95	30.07	+.02	17.1	−5.3	43	23	29	−14	14	6	39	14	10	76	2.79	−1.2	12	6.5	n.	20	n.	11	16	7	8	4.3	24.7	8.0
Concord [2]	289	54	72	29.77	30.09	+.04	20.2	−1.4	42	23	28	−1	14	12	32	15	12	82	2.23	−.8	8	6.1	nw.	22	nw.	13	8	10	13	6.2	23.8	14.5
Burlington [1]	403	11	48	29.70	30.16	+.11	13.4	−5.4	37	18	21	−12	30	6	30	11	8	83	1.45	−.3	17	8.0	n.	31	s.	22	4	6	21	7.5	13.2	2.4
Northfield	876	12	60	29.15	30.15	+.10	12.6	−2.6	40	23	24	−20	30	2	38	8	6	89	1.15	−1.2	14	6.6	n.	21	ne.	13	7	4	20	7.0	16.4	8.1
Boston	124	33	62	29.94	30.08	+.03	25.2	−2.7	48	23	32	3	30	19	22	22	16	69	4.21	+.6	9	12.5	nw.	35	ne.	17	7	8	16	6.6	20.4	7.5
Nantucket	12	14	90	30.03	30.04	.00	30.8	−.5	50	17	35	10	14	26	19	28	23	73	3.45	−.3	11	16.4	w.	48	ne.	25	8	7	16	6.4	1.0	.3
Block Island	26	11	46	30.04	30.07	.00	29.0	−2.0	45	23	34	7	30	24	22	27	22	72	3.93	+.4	12	20.2	nw.	45	e.	24	11	9	11	5.1	2.1	.9
Providence [2]	159	65	25	29.91	30.09	+.03	26.5	−.7	49	23	34	2	14	20	22	22	16	68	3.57	−.1	10	13.9	nw.	37	nw.	20	8	11	12	6.0	14.9	5.0
Hartford [1]	159	122	----	29.93	30.12	+.05	23.5	−2.0	45	23	31	0	30	16	28	21	16	73	1.95	−2.0	10	9.7	n.	27	nw.	1	8	5	18	6.6	10.3	3.7
New Haven [2]	107	74	68	30.00	30.12	+.04	26.8	−1.4	48	23	33	3	30	20	23	24	20	78	3.21	−.8	10	10.2	n.	24	n.	11	10	4	17	6.2	9.2	3.1
Middle Atlantic States							**31.9**	**−0.3**										**73**	**2.69**	**−0.5**										**6.4**		
Albany [1]	97	26	40	30.04	30.15	+.08	18.4	−4.7	40	23	26	−7	30	11	29	16	12	71	1.98	−.4	13	10.3	n.	34	w.	29	6	8	17	6.9	20.1	5.1
Binghamton	871	57	79	29.19	30.16	+.08	23.7	−.4	44	22	31	2	30	17	28	22	18	8	2.18	−.3	18	6.9	nw.	28	w.	4	2	7	22	8.0	23.0	10.5
New York	314	415	454	29.77	30.12	+.02	29.8	−1.1	49	1	37	9	30	23	25	26	19	65	3.33	−.3	10	15.5	n.	46	nw.	13	10	4	17	6.2	6.1	3.6
Harrisburg	374	30	49	29.74	30.16	+.06	29.7	+.7	46	1	36	14	14	23	24	26	21	74	2.38	−.7	11	8.3	nw.	26	nw.	4	7	4	20	7.2	10.3	5.2
Philadelphia [2]	114	174	367	30.02	30.15	+.04	31.8	−.8	52	23	38	15	30	26	22	27	24	78	3.16	−.1	12	13.4	n.	31	nw.	13	11	4	16	5.9	6.2	1.8
Reading	323	47	306	29.79	30.17	----	29.9	+.5	50	1	36	13	14	24	23	26	20	66	3.53	.0	11	11.2	nw.	40	nw.	4	8	6	17	6.6	19.7	7.2
Scranton	805	72	104	29.25	30.15	+.06	25.4	−1.2	45	22	32	6	14	19	24	----	----	----	1.49	−1.5	12	6.9	n.	24	nw.	13	5	6	20	7.3	16.1	6.7
Atlantic City	52	37	172	30.06	30.12	+.01	34.3	+1.8	56	23	41	17	30	28	22	31	25	72	4.31	+.8	11	16.8	w.	45	ne.	16	8	7	16	6.3	.2	.0
Trenton	190	89	107	29.93	30.14	----	29.6	−.9	49	23	36	11	30	24	21	27	21	68	3.49	+.2	11	10.0	n.	26	nw.	4	10	6	15	6.3	7.6	2.0
Baltimore [3]	123	100	215	30.02	30.16	+.04	34.7	+.9	55	23	41	18	14	29	25	29	24	73	3.29	−.2	10	10.6	n.	35	sw.	4	11	6	14	6.0	5.5	2.0
Washington	112	62	85	30.04	30.17	+.04	34.8	+1.4	55	23	40	21	21	29	22	31	24	64	3.04	−.5	11	7.5	nw.	26	nw.	4	11	5	15	----	3.2	.0
Cape Henry	18	8	54	30.11	30.13	----	40.4	+.2	64	23	46	24	9	35	28	37	33	78	2.71	−.4	9	14.8	n.	40	n.	28	9	10	12	5.8	2.0	.0
Lynchburg	686	144	184	29.41	30.18	+.05	37.6	+.1	65	23	46	18	6	30	30	32	26	68	2.38	−1.0	8	7.4	nw.	33	nw.	4	13	4	14	5.9	1.5	.0
Norfolk [2]	91	80	125	30.04	30.15	+.02	40.4	−.2	68	23	47	24	6	34	28	35	32	79	2.12	−1.0	9	10.1	n.	27	nw.	24	9	5	17	6.4	3.3	.0
Richmond [2]	144	11	52	30.00	30.16	+.02	37.0	−.9	64	23	45	17	21	29	32	31	27	79	2.32	−.9	8	8.1	ne.	29	n.	24	11	6	14	5.6	.3	.0
Wytheville	2,304	49	55	27.69	30.16	+.02	33.2	+.2	56	23	41	8	6	25	36	29	26	79	1.33	−1.6	8	7.6	w.	32	w.	4	8	9	14	6.3	2.0	T
South Atlantic States							**45.6**	**+0.7**										**76**	**1.66**	**−2.0**										**5.3**		
Asheville	2,253	89	104	27.76	30.20	+.05	38.8	+3.4	63	2	48	13	6	29	36	33	28	73	1.13	−2.0	8	9.4	nw.	26	nw.	4	10	9	12	5.4	T	.0
Charlotte [2]	779	63	86	29.30	30.15	.00	42.5	+1.3	66	24	52	18	6	33	33	36	31	74	1.36	−2.6	9	6.5	ne.	23	sw.	4	13	6	12	5.2	.0	.0
Greensboro [1]	886	6	56	29.19	30.17	----	37.8	----	64	23	47	16	6	28	37	33	29	79	2.11	----	6	7.5	n.	25	sw.	4	8	9	14	6.0	T	.0
Hatteras	11	5	50	30.11	30.12	−.02	45.0	−2.1	64	24	51	29	20	39	28	41	39	84	2.73	−1.7	7	13.6	n.	36	w.	4	10	7	14	5.7	.0	.0
Raleigh [2]	376	103	146	29.74	30.16	+.03	40.6	−.5	71	23	50	17	6	31	35	35	30	73	2.03	−1.6	8	8.2	ne.	24	n.	24	13	4	14	5.5	.0	.0
Wilmington	72	73	107	30.07	30.15	+.01	46.1	−.4	71	2	55	25	6	37	29	40	35	72	1.62	−1.7	7	8.6	n.	25	nw.	4	11	10	10	5.0	T	.0
Charleston [2]	48	11	92	30.10	30.15	.00	49.6	−.3	72	2	56	31	8	43	23	41	38	80	1.63	−1.4	7	9.5	n.	26	n.	11	13	5	13	5.1	.0	.0
Columbia, S. C. [2]	347	70	91	29.78	30.16	+.01	47.0	+1.0	70	24	56	26	8	38	32	39	34	73	1.16	−2.3	7	7.7	ne.	27	sw.	30	16	5	10	4.6	.0	.0
Greenville, S. C.	1,040	70	78	29.03	30.16	----	43.4	+3.1	67	13	52	22	6	34	33	----	----	----	1.69	−3.2	9	6.7	ne.	25	sw.	4	14	5	12	5.1	.0	.0
Augusta [2]	182	62	77	29.95	30.15	−.01	48.0	+1.0	70	24	58	27	9	38	39	40	34	69	1.93	−2.0	5	5.3	nw.	19	w.	30	14	4	13	5.0	.0	.0
Savannah [2]	65	73	152	30.08	30.15	.00	52.7	+1.3	74	23	62	31	8	44	32	44	39	76	.53	−2.2	5	9.3	e.	23	n.	3	11	7	13	5.3	.0	.0
Jacksonville [3]	43	86	110	30.10	30.15	.00	55.4	.0	76	2	64	32	20	47	29	46	43	82	1.97	−.8	11	6.8	nw.	21	ne.	6	10	9	12	5.5	.0	.0
Florida Peninsula							**65.2**	**+0.4**										**83**	**2.62**	**+0.2**										**5.5**		
Key West [3]	21	10	64	30.06	30.09	−.01	69.4	−.1	82	3	75	52	20	64	19	64	61	83	1.17	−.8	7	10.7	n.	29	nw.	10	14	5	12	4.8	.0	.0
Miami [3]	25	124	168	30.06	30.09	−.04	66.7	+.2	80	3	74	42	11	59	25	59	57	85	3.45	+.9	8	9.4	nw.	31	nw.	10	6	14	11	6.0	.0	.0
Tampa [2]	35	88	197	30.10	30.13	+.01	59.4	+1.0	77	1	68	38	20	51	26	53	50	82	3.24	+.6	8	11.1	n.	35	w.	16	8	13	10	5.7	.0	.0
East Gulf States							**50.5**	**+1.1**										**75**	**2.45**	**−2.0**										**5.2**		
Atlanta [1]	1,173	5	72	28.90	30.16	+.01	44.2	−.4	67	23	54	26	6	35	33	38	32	68	1.42	----	9	10.3	nw.	26	w.	30	12	6	13	5.2	.0	.0
Macon [3]	370	79	87	29.75	30.15	−.01	48.4	+1.6	70	13	59	28	9	38	40	41	36	72	1.29	−2.9	5	6.6	nw.	18	sw.	22	12	8	11	5.1	.0	.0
Thomasville	273	49	58	29.87	30.17	+.01	51.3	+.5	75	14	63	29	20	40	38	42	40	----	1.02	----	5	----	n.	----	----	----	----	----	----	----	.0	.0
Apalachicola	35	11	51	30.12	30.15	----	53.4	−.3	74	24	61	33	20	46	25	48	45	78	3.12	−.5	9	8.1	n.	28	e.	5	10	7	14	5.8	.0	.0
Pensacola	56	54	79	30.11	30.17	+.03	53.2	+.7	74	24	62	32	20	44	25	48	44	77	2.75	−1.2	7	7.4	n.	24	nw.	16	12	9	10	4.9	.0	.0
Anniston	741	9	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Birmingham [2]	700	11	48	29.43	30.19	+.03	46.7	+1.6	71	23	56	25	6	38	33	39	34	74	2.48	−3.0	7	7.3	n.	22	se.	14	10	10	11	4.9	T	.0
Mobile [2]	57	86	161	30.11	30.17	+.02	52.8	+1.3	73	24	63	31	20	43	30	46	43	81	3.53	−1.3	7	9.6	n.	34	nw.	16	9	11	11	5.5	.0	.0
Montgomery [2]	218	92	105	----	30.18	+.02	49.7	+1.5	71	22	59	31	20	40	----	----	----	66	3.03	−2.2	5	7.0	n.	19	w.	9	10	12	9	----	.0	.0
Meridian [1]	375	67	92	29.78	30.19	+.03	48.8	+1.8	75	23	60	26	20	38	36	42	39	79	1.95	−3.4	7	5.9	n.	22	sw.	16	8	14	9	5.2	T	.0
Vicksburg	247	82	102	29.91	30.18	+.03	50.9	+2.7	76	23	60	25	19	42	27	41	38	80	2.53	−2.8	6	8.6	n.	30	sw.	16	9	13	9	5.1	T	.0
New Orleans [2]	53	76	84	30.11	30.17	+.04	55.8	+1.6	76	22	64	33	19	48	23	49	45	74	3.87	−.5	8	6.7	ne.	29	e.	5	11	11	9	5.1	.0	.0
Port Eads, La.	9	4	35	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
West Gulf States							**53.3**	**+3.7**										**78**	**2.23**	**−0.6**										**6.4**		
Shreveport [2]	249	92	227	29.90	30.17	+.03	51.2	+4.2	70	23	60	28	19	42	27	45	40	75	3.57	−.4	10	10.2	s.	44	sw.	15	7	9	15	6.3	T	.0
Bentonville	1,303	12	51	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Fort Smith	463	57	82	29.66	30.15	+.01	43.2	+3.7	72	1	51	18	18	36	34	38	33	70	4.18	+1.6	10	7.6	e.	21	s.	21	10	4	17	6.3	T	.0
Little Rock [2]	357	94	102	29.79	30.18	+.03	44.3	+2.9	68	1	52	22	19	36	31	39	35	79	2.15	−2.6	10	7.7	e.	21	s.	21	10	6	15	6.1	.4	.0
Austin [3]	605	68	90	29.50	30.15	----	53.6	+4.1	76	1	63	28	19	45	32	48	44	78	1.52	−.6	6	6.8	n.	24	sw.	21	9	9	13	5.6	.0	.0
Brownsville [2]	57	88	96	30.03	30.09	----	64.0	+4.2	80	25	71	35	19	57	28	59	56	85	.73	−.8	4	10.5	e.	29	nw.	17	3	10	18	7.4	.0	.0
Corpus Christi [2]	20	11	78	30.10	30.12	+.02	60.4	+4.4	76	22	66	38	18	55	19	55	53	86	1.06	−.5	7	9.7	s.	30	ne.	27	5	6	20	7.4	.0	.0
Dallas [1]	512	220	227	29.60	30.16	----	48.2	----	71	1	58	26	18	39	34	43	39	78	.55	−1.8	7	10.2	n.	38	s.	21	9	3	19	6.6	T	.0
Fort Worth	679	35	56	29.43	30.16	+.04	48.2	+2.8	71	21	58	26	18	39	35	43	39	78	1.45	−.5	6	10.7	s.	36	s.	21	8	9	14	6.4	.0	.0
Galveston [3]	54	106	114	30.09	30.14	+.01	57.3	+3.5	73	26	62	36	19	53	20	53	51	84	2.33	−1.1	8	9.8	s.	24	e.	27	8	13	10	5.8	.0	.0
Houston [3]	138	157	190	30.00	30.16	----	57.0	+4.3	76	1	64	32	19	50	24	51	48	79	2.06	−1.6	9	10.1	se.	29	sw.	15	7	7	17	6.5	.0	.0
Palestine	510	64	72	29.63	30.17	+.05	51.5	+3.3	71	1	60	28	19	43	28	46	40	71	3.15	−.3	13	7.1	s.	20	s.	21	8	7	16	6.3	.0	.0
Port Arthur	34	57	34	30.11	30.15	----	55.9	----	77	26	62	30	19	49	22	----	----	----	4.08	+.4	12	12.3	ne.	29	ne.	5	6	12	13	6.3	.0	.0
San Antonio [2]	693	111	301	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

See footnotes at end of table.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean Min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, lengths	Total snowfall	Average depth on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F*		*°F*	*°F.*		*°F*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							34.8	+1.4										80	2.38	−1.4											7.5		
Chattanooga [1]	762	21	54	29.35	30.19	+0.03	41.0	−.2	67	23	52	19	6	30	41	36	32	80	4.11	-----	9	6.0	s.	25	sw.	4	11	5	15	6.2	T	0.0
Knoxville [2]	995	66	84	29.10	30.18	+.03	40.7	+1.9	63	2	49	17	6	32	30	35	30	75	2.28	−2.4	11	5.6	ne.	23	w.	4	10	7	14	5.8	T	.0
Memphis [2]	399	78	86	29.74	30.18	+.02	43.3	+2.4	66	14	50	20	19	36	27	38	34	77	2.82	−1.9	9	7.8	sw.	21	w.	17	8	10	13	6.3	T	.0
Nashville [2]	546	167	187	29.59	30.19	+.03	40.4	+1.8	63	14	48	16	6	33	36	36	32	77	1.81	−3.0	12	8.8	nw.	25	s.	15	9	4	18	6.8	T	.0
Lexington	989	6	----	29.09	30.20	+.07	34.4	+1.5	61	2	42	9	6	27	32	----	----	----	2.32	-----	12	----	----	----	----	----	7	7	17	7.0	0.3	.0
Louisville [2]	525	106	120	29.60	30.18	+.04	36.1	+1.7	58	1	42	12	5	30	26	32	28	78	2.32	−1.7	13	9.0	nw.	28	sw.	22	7	8	16	6.9	.3	.0
Evansville [1]	431	76	116	29.71	30.19	+.05	35.2	+1.7	57	1	43	11	19	28	33	32	28	78	2.28	−1.5	12	8.1	nw.	25	nw.	4	6	6	19	7.5	.3	.0
Indianapolis [2]	823	98	129	29.26	30.18	+.06	31.2	+2.8	54	1	37	4	5	25	28	25	85	1.68	−1.3	12	8.6	nw.	27	nw.	4	6	1	24	8.0	3.8	.1
Terre Haute	575	68	149	29.55	30.20	-----	32.2	----	55	12	39	6	5	26	28	29	26	83	1.24	−1.5	12	9.7	nw.	25	nw.	4	4	5	22	7.8	3.5	T
Cincinnati [2]	627	11	51	29.49	30.19	+.07	32.8	+2.5	55	2	39	6	5	26	28	30	27	81	2.06	−1.4	13	7.8	sw.	26	w.	4	4	5	22	8.1	4.0	T
Columbus [2]	822	90	110	29.26	30.17	+.06	31.6	+3.0	55	2	37	6	5	26	23	28	25	83	2.05	−1.0	11	9.6	w.	34	w.	4	3	3	25	8.5	6.4	2.0
Dayton	900	186	213	29.19	30.18	-----	30.4	+.9	54	2	36	5	5	24	25	27	25	87	1.72	−1.5	12	10.0	w.	32	s.	10	3	6	22	8.2	5.5	1.1
Elkins [2]	1,947	61	78	28.05	30.18	+.06	31.2	+.8	57	1	39	3	21	24	43	27	24	82	3.31	−.5	21	6.5	w.	30	w.	4	2	6	23	8.5	6.2	1.0
Parkersburg	637	77	84	29.47	30.18	+.06	33.4	+.9	61	2	40	10	20	27	30	30	27	78	2.72	−.9	13	5.8	sw.	29	nw.	4	4	3	24	8.1	2.5	.0
Pittsburgh [1]	842	39	54	29.23	30.16	+.05	28.6	−2.1	53	17	35	7	5	22	31	26	23	82	2.98	−.1	19	11.5	nw.	36	w.	4	2	5	24	8.4	12.3	2.5
Lower Lake Region							24.7	+0.2										83	1.76	−0.9										8.6		
Buffalo [2]	768	243	280	29.29	30.16	+.09	24.5	−.1	44	17	30	4	14	19	23	23	20	87	2.36	−1.9	22	15.6	w.	51	w.	4	2	5	24	8.4	17.3	5.9
Canton	448	10	61	29.66	30.18	-----	12.2	−4.1	41	18	21	−20	30	3	39	11	10	93	1.05	−1.4	15	7.4	w.	21	w.	4	7	4	20	7.3	13.4	5.4
Ithaca	836	77	100	----	30.12	-----	24.0	−.3	43	18	30	2	14	17	25	----	----	70	1.46	−.7	16	9.4	nw.	31	se.	2	2	4	25	8.6	17.9	8.0
Oswego	335	71	85	29.78	30.17	+.10	22.6	−1.3	43	18	29	−2	14	16	26	21	17	77	2.03	−.9	19	9.5	se.	25	se.	2	1	4	26	8.9	22.2	11.5
Rochester [2]	523	86	102	----	30.16	+.09	22.8	−1.8	46	22	30	4	20	16	29	----	----	83	1.93	−.9	21	11.0	w.	36	w.	5	1	8	22	----	13.0	6.7
Syracuse [2]	596	65	79	29.49	30.17	+.10	22.6	−1.5	47	18	30	−2	13	15	31	21	19	87	2.25	−.8	21	9.2	ne.	29	w.	5	2	4	25	8.6	23.5	7.3
Erie [2]	714	57	81	29.36	30.16	+.08	28.4	+1.6	47	17	33	12	14	24	24	26	24	87	2.40	−.4	14	8.8	w.	24	sw.	4	0	3	28	9.2	14.9	4.2
Cleveland [2]	762	267	318	29.31	30.16	+.07	29.6	+3.1	56	2	34	12	5	25	25	27	24	84	1.85	−.7	16	15.0	w.	44	w.	4	0	5	26	9.2	15.2	2.3
Sandusky	629	5	67	----	----	-----	28.8	+2.5	53	2	34	12	5	24	24	----	----	----	1.30	−1.0	14	10.0	w.	27	w.	4	0	4	27	9.3	8.1	1.8
Toledo [2]	628	79	87	29.46	30.17	+.08	27.4	+1.6	50	2	32	9	5	23	21	25	22	83	1.42	−.7	15	10.6	w.	29	w.	4	3	4	24	8.3	6.1	.6
Fort Wayne [2]	857	69	84	29.22	30.18	-----	27.4	+1.2	51	2	33	6	5	22	25	24	22	85	1.60	−.7	12	9.0	w.	28	w.	4	1	6	24	8.5	5.4	1.4
Detroit [1]	730	5	78	29.35	30.18	+.10	26.2	+1.8	47	2	32	10	14	21	25	25	21	80	1.46	−.6	15	10.7	nw.	31	w.	4	1	5	25	8.7	6.4	.9
Upper Lake Region							21.6	+3.7										85	1.64	−0.2										8.3		
Alpena	609	13	89	29.48	30.17	+.13	20.8	+1.7	35	2	27	−6	14	14	24	20	18	89	1.95	+.1	19	10.7	nw.	36	se.	2	1	3	27	8.7	23.4	15.7
Escanaba	612	51	72	29.50	30.19	+.14	20.5	+5.1	36	30	26	2	20	15	21	20	18	84	.97	−.5	14	10.8	nw.	31	nw.	18	1	4	26	8.9	13.8	6.6
Grand Rapids [2]	707	70	244	29.36	30.16	+.10	26.2	+1.7	42	2	31	10	14	21	17	23	21	86	1.94	−.4	15	11.1	e.	34	sw.	30	1	4	26	8.8	10.4	1.1
Lansing	878	5	90	29.19	30.18	-----	24.8	+2.4	40	2	30	7	14	20	19	23	21	90	1.58	−.2	14	8.5	nw.	26	w.	4	2	6	23	8.5	6.2	.5
Marquette	734	44	73	29.34	30.18	+.14	21.0	+4.7	37	2	26	8	24	16	20	19	17	86	1.32	−1.0	22	8.7	nw.	24	nw.	4	1	6	24	8.4	12.6	12.4
Sault Sainte Marie [1]	614	11	52	29.48	30.19	+.16	14.3	+1.0	33	2	22	−9	14	7	27	12	8	81	1.09	−.9	14	7.2	se.	20	e.	2	3	8	20	7.9	14.5	12.0
Chicago	673	7	131	29.42	30.18	+.08	28.1	+4.4	50	2	34	3	5	23	25	25	23	80	2.26	+.4	11	10.4	w.	26	nw.	4	3	8	20	8.0	10.7	3.2
Green Bay	617	109	141	29.48	30.19	+.13	20.9	+5.2	36	1	27	−2	5	15	25	20	17	82	1.70	+.2	8	10.7	sw.	27	ne.	26	5	4	22	8.1	11.3	5.0
Milwaukee [2]	681	126	221	29.41	30.18	+.10	25.6	+5.0	41	2	31	1	19	20	25	23	20	84	2.50	+.7	11	13.0	w.	30	n.	22	5	4	22	7.8	7.4	2.5
Duluth	1,133	5	47	28.90	30.19	+.10	13.5	+5.6	35	31	21	−12	18	6	32	12	10	85	1.08	+.1	13	12.2	nw.	43	nw.	17	3	5	23	7.8	10.5	7.7
North Dakota							11.1	+5.3										87	0.62	+1.5										7.0		
Moorhead, Minn. [2]	940	50	58	-----	30.24	+.10	10.6	+6.8	39	11	19	−20	18	2	----	----	----	90	.66	.0	12	8.6	s.	22	nw.	3	7	5	19	----	6.8	4.1
Bismarck [1]	1,677	4	41	28.36	30.24	+.11	11.6	+3.8	47	31	21	−18	18	3	37	10	8	87	.57	+.1	7	9.4	nw.	36	nw.	3	6	9	16	7.2	6.7	T
Devils Lake	1,478	11	44	28.55	30.23	+.11	6.9	+5.1	39	31	15	−26	25	−2	39	6	5	94	.78	+.3	10	8.7	nw.	26	nw.	3	4	3	24	8.1	8.0	5.2
Lemmon, S. D.	2,602	4	38	27.34	30.20	-----	17.0	----	52	31	28	−12	26	6	45	15	12	---	.13	-----	2	----	nw.	----	----	----	8	9	14	----	1.3	.0
Grand Forks	832	12	67	29.28	30.25	-----	7.2	+3.7	40	31	17	−26	25	−3	42	6	4	---	1.25	+7.4	9	----	nw.	----	----	----	3	5	23	----	11.1	13.2
Williston	1,878	42	50	28.12	30.20	+.09	13.3	+6.9	44	31	22	−18	24	4	40	12	8	78	.33	−.2	4	6.5	se.	23	nw.	3	11	8	12	5.8	4.2	4.3
Upper Mississippi Valley							26.1	+5.1										84	2.17	+0.7										7.3		
Minneapolis-St. Paul Minn. [1]	919	32	61	29.16	30.21	+.10	17.4	+4.7	41	31	25	−8	18	10	31	16	13	82	.74	−.1	8	9.7	se.	28	w.	2	8	6	17	6.9	3.3	2.3
Springfield, Minn.	1,025	4	42	29.06	30.22	-----	17.7	+5.2	44	31	26	−10	11	10	33	17	14	---	.72	-----	7	----	----	----	----	----	6	7	18	----	3.8	1.0
La Crosse [2]	714	11	48	29.39	30.20	+.09	21.4	+5.3	40	1	28	−2	4	14	29	18	16	84	1.88	+.8	10	5.6	s.	17	nw.	17	7	6	18	7.1	12.3	5.0
Madison [2]	974	70	78	29.09	30.19	+.09	22.1	+5.4	38	12	28	−4	19	16	21	21	18	85	2.10	+.7	13	8.7	nw.	22	nw.	17	3	11	17	7.4	7.5	4.2
Charles City	1,015	10	51	29.07	30.22	+.08	20.4	+6.7	41	12	28	−4	18	13	33	19	17	89	1.80	+.8	11	6.8	nw.	24	w.	3	7	6	18	7.1	9.7	4.8
Davenport [2]	606	66	161	29.50	30.20	+.08	27.0	+5.2	51	12	32	2	19	22	24	24	22	87	2.78	+1.4	13	10.4	nw.	32	nw.	2	6	6	19	7.4	14.3	6.6
Des Moines [2]	860	5	99	29.22	30.19	+.05	25.6	+5.5	50	11	33	0	18	18	29	23	20	84	2.22	+1.2	12	9.7	nw.	27	nw.	3	7	6	18	7.0	14.4	2.8
Dubuque	699	60	79	29.41	30.20	+.08	24.8	+5.7	46	12	31	0	19	19	24	23	20	81	1.83	+.5	10	6.8	nw.	21	nw.	3	4	5	22	7.9	8.0	1.5
Keokuk	614	64	78	29.51	30.20	+.06	29.2	+4.3	55	12	35	4	18	24	24	----	----	---	3.23	+1.7	15	7.6	nw.	30	nw.	3	8	3	20	7.2	10.1	1.3
Cairo	358	87	93	29.79	30.19	+.03	38.6	+3.7	63	14	46	15	19	32	30	35	----	----	2.33	−1.4	12	8.0	n.	29	sw.	16	5	7	19	7.5	T	.0
Peoria [2]	609	11	45	29.50	30.18	+.06	28.4	+5.3	51	12	34	2	19	23	25	26	24	88	3.56	+1.8	13	7.1	w.	22	w.	3	7	5	19	7.0	9.1	3.1
Springfield, Ill. [2]	636	5	191	29.47	30.18	+.05	30.9	+4.4	55	12	37	5	19	25	27	27	25	88	2.67	+.6	15	10.9	e.	25	nw.	4	5	5	21	7.6	8.4	T
St. Louis [2]	568	179	303	29.55	30.18	+.04	35.4	+4.3	64	12	42	10	18	29	31	32	27	74	2.38	.0	12	10.6	nw.	30	sw.	21	7	6	18	7.0	3.3	.0
Missouri Valley							28.1	+4.4										85	2.23	+1.0										6.8		
Columbia, Mo. [2]	784	6	66	29.31	30.18	+.05	33.8	+4.6	64	12	40	8	19	27	30	30	27	83	2.85	+.9	14	7.5	nw.	21	nw.	4	8	5	18	7.1	3.4	.0
Kansas City [1]	963	38	76	29.11	30.18	+.03	32.3	+4.0	62	12	39	5	18	26	30	30	27	82	4.91	+3.7	12	9.0	nw.	31	nw.	17	8	2	21	7.1	11.8	.1
St. Joseph [2]	967	11	49	29.12	30.19	-----	30.3	+4.8	60	12	37	4	18	24	26	28	26	90	3.36	+2.1	13	8.3	nw.	27	nw.	17	10	3	18	6.6	13.5	1.8
Springfield, Mo. [1]	1,324	5	78	28.72	30.16	+.02	36.8	+3.3	64	12	45	8	18	29	34	33	31	84	2.82	−.5	14	10.2	se.	28	w.	10	6	5	20	7.4	1.3	.0
Topeka	987	65	87	29.09	30.18	-----	31.8	+4.2	62	12	39	6	18	25	29	30	27	85	3.79	+2.8	15	7.6	nw.	28	nw.	17	8	2	21	7.3	8.7	.0
Lincoln [2]	1,189	11	81	28.88	30.21	+.06	26.8	+4.0	56	11	34	2	18	28	24	24	21	87	1.57	+.9	11	8.5	n.	31	nw.	3	6	9	16	6.9	9.7	1.0
Omaha [1]	1,105	31	44	28.98	30.21	+.06	25.9	+4.0	54	11	34	2	18	18	31	24	21	85	1.03	+.3	8	9.5	nw.	37	nw.	17	5	7	19	7.3	12.2	2.7
Valentine	2,598	46	54	27.36	30.19	+.07	23.6	+4.7	57	11	34	−6	5	14	37	21	19	86	.49	.0	7	7.2	w.	24	nw.	3	8	7	16	5.9	8.0	T
Sioux City [2]	1,138	64	106	28.94	30.22	+.07	23.6	+5.8	56	11	32	−4	18	15	36	21	19	87	.90	+.2	9	9.1	nw.	32	nw.	17	7	8	16	6.6	6.2	2.5
Huron [1]	1,301	26	41	28.77	30.24	+.08	16.1	+4.8	47	11	25	−15	18	7	31	15	12	84	.61	.0	9	11.6	nw.	35	nw.	3	13	3	15	5.7	11.2	.3
Northern Slope							25.2	+5.1										77	.34	−0.4										6.4		
Billings [1]	3,570	18	39	26.35	30.12	-----	29.8	----	59	10	41	−3	25	19	40	25	17	64	.04	-----	3	11.3	sw.	31	sw.	30	8	7	16	6.8	1.2	.0
Havre	2,507	11	67	27.42	30.17	+.07	20.2	+7.3	59	10	30	−13	24	10	48	18	13	78	.37	−.4	7	7.7	e.	25	sw.	10	6	12	13	6.6	5.8	T
Helena	4,124	85	111	25.83	30.21	+.06	22.6	+2.4	44	26	33	−4	24	12	41	20	17	80	.25	−.6	7	4.8	sw.	34	w.	26	6	9	16	7.2	4.8	T
Missoula [2]	3,263	80	91	26.69	30.19	-----	27.6	+5.3	46	28	35	7	2	20	24	24	23	90	.55	−.5	11	5.0	se.	23	se.	25	5	7	19	7.1	3.7	.0
Kalispell	2,973	48	56	26.99	30.16	+.04	24.4	+4.0	43	26	31	5	3	18	30	24	21	85	1.26	−.3	13	3.8	w.	16	nw.	24	0	3	28	9.1	17.9	4.8
Miles City [2]	2,371	48	55	27.59	30.19	+.07	22.4	+7.9	53	28	34	−10	4	11	40	18	15	77	.07	−.6	3	5.0	s.	18	nw.	3	4	10	17	7.0	2.4	.0
Rapid City [2]	3,259	50	58	26.68	30.19	+.09	27.2	+5.2	65	10	39	−4	25	16	53	20	15	74	.12	−.3	4	6.4	w.	29	nw.	3	14	9	8	4.5	1.2	.0
Cheyenne [1]	6,094	5	39	23.99	30.14	+.09	30.2	+4.7	61	11	43	8	6	18	41	24	15	57	.33	−.1	3	10.9	nw.	40	nw.	18	10	5	16	6.4	4.0	T
Lander	5,352	60	68	24.69	30.23	+.11	20.8	+2.5	47	19	32	0	2	9	33	18	15	83	.15	−.4	2	3.2	s.	14	ne.	26	11	10	10	5.3	1.5	.3
Sheridan [6]	3,790	10	47	26.14	30.17	-----	25.4	----	57	10	38	−3	6	13	43	21	18	79	.19	−.7	4	4.9	nw.	25	nw.	3	10	7	14	6.1	4.4	T
Yellowstone Park	6,241	12	46	23.90	30.26	+.12	24.2	+6.5	43	9	34	−5	2	15	32	21	17	75	.28	−.5	10	7.2	s.	26	sw.	25	9	9	13	5.9	4.0	3.2
North Platte [6]	2,821	11	51	27.15	30.19	+.07	27.8	+4.9	61	10	37	−1	26	18	37	23	21	85	.30	−.1	6	6.5	n.	21	nw.	1	11	13	7	4.4	2.9	T

See footnotes at end of table.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean Min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, lengths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Middle Slope							**33.4**	**+3.9**										**78**	**0.90**	**+0.4**										**6.4**		
Denver [2]	5,292	106	113	24.74	30.12	+0.07	34.3	+4.5	61	9	44	14	4	24	36	25	17	60	.71	+.3	3	6.4	s.	22	ne.	16	12	10	9	4.7	7.7	2.7
Pueblo	4,690	79	86	25.31	30.12	+.07	32.8	+2.9	63	28	46	9	6	20	46	27	21	71	.34	-----	5	6.0	nw.	26	n.	29	11	8	12	5.5	2.8	.0
Concordia	1,392	50	58	28.66	30.19	+.05	29.8	+3.4	57	11	37	5	24	22	31	28	25	86	1.15	+.5	11	6.9	ne.	33	n.	17	7	6	18	6.7	5.6	T
Dodge City	2,509	10	86	27.47	30.15	+.04	33.6	+4.6	64	10	43	13	18	25	36	30	27	82	.97	+.6	7	8.9	n.	31	n.	17	6	6	19	7.1	1.3	.0
Wichita [2]	1,358	85	93	28.69	30.17	+.04	34.4	+3.1	57	21	42	12	18	27	26	32	30	88	1.53	+.8	13	12.3	nw.	38	nw.	17	9	1	21	7.0	3.8	.0
Oklahoma City [2]	1,214	10	47	28.84	30.16	+.05	41.4	+5.0	66	29	49	19	18	33	36	37	34	81	1.12	−.1	8	9.1	s.	24	nw.	17	6	7	18	7.4	T	.0
Chadron	3,439	5	44	26.51	30.17	-----	27.8	-----	60	10	40	−4	18	16	50	24	19	---	.45	-----	6	-----	sw.	----	----	----	10	4	10	----	6.2	T
Southern Slope							**46.3**	**+3.6**										**70**	**0.81**	**+0.2**										**5.9**		
Abilene [2]	1,738	10	56	28.28	30.12	+.03	48.4	+4.2	75	25	58	24	18	38	34	42	37	74	1.75	+.8	11	9.1	s.	31	w.	15	8	8	15	6.4	T	.0
Amarillo [2]	3,676	10	49	26.31	30.11	+.05	39.4	+4.1	69	20	50	19	18	29	36	31	27	77	.40	−.1	5	8.6	sw.	28	w.	21	11	8	12	5.3	.9	.0
Del Rio	960	63	71	29.09	30.10	+.04	55.4	+3.1	79	15	65	33	19	46	36	49	42	68	.61	0	7	7.8	se.	31	w.	15	9	7	15	6.1	0	.0
Roswell	3,566	75	85	-----	30.09	+.05	42.0	+2.8	66	19	54	17	4	30	----	----	----	62	.49	-----	6	6.2	s.	38	nw.	15	10	9	12	----	T	.0
Southern Plateau							**42.4**	**−2.6**										**71**	**.93**	**−.01**										**6.0**		
El Paso [2]	3,778	82	101	26.23	30.06	+.05	46.7	+1.7	67	26	56	26	18	37	32	39	31	60	.46	0	4	7.9	w.	27	e.	27	13	8	10	5.1	.0	.0
Albuquerque [1]	4,972	5	34	25.10	30.10	-----	36.0	+1.9	51	9	45	18	4	27	29	31	26	71	1.17	+.8	11	7.3	n.	34	se.	28	9	5	17	6.1	.9	.0
Santa Fe	7,013	38	53	23.24	30.15	+.11	31.4	+2.6	53	11	40	10	4	23	28	26	23	79	1.23	+.6	12	5.6	n.	19	n.	15	8	4	19	6.8	13.8	.0
Flagstaff	6,907	10	59	23.33	30.03	−.02	29.4	+2.7	53	19	40	4	6	19	38	27	25	83	1.19	−1.6	14	7.1	nw.	31	ne.	27	6	15	10	5.9	14.0	----
Phoenix [2]	1,107	39	87	28.87	30.04	+.01	54.8	+3.6	76	9	66	36	18	44	32	48	43	72	1.04	+.2	5	4.4	e.	26	e.	28	8	12	11	5.9	.0	.0
Yuma	142	9	54	-----	-----	-----	56.4	+2.0	72	31	67	39	4	46	----	51	43	62	.83	-----	4	4.9	n.	18	n.	27	16	8	7	----	----	----
Independence	3,957	5	26	26.00	30.09	+.21	41.8	+3.6	60	31	53	23	3	31	30	36	27	---	.58	−.3	8	4.2	nw.	----	----	----	4	14	13	----	.0	.0
Middle Plateau							**32.9**	**+5.7**										**78**	**0.65**	**0.0**										**7.0**		
Ely, Nev.	6,262	5	41	23.90	30.16	-----	27.2	-----	51	18	39	0	3	15	40	25	21	78	.35	-----	9	9.6	s.	36	se.	7	7	4	20	7.1	3.9	T
Reno [2]	4,527	61	76	-----	30.07	−.06	38.0	+6.4	58	18	47	20	2	29	29	33	----	74	.62	-----	9	5.1	w.	24	s.	21	8	15	8	----	.6	.0
Tonopah	6,090	12	20	24.04	30.09	-----	34.6	-----	50	30	42	22	22	28	25	30	25	---	.04	-----	2	-----	se.	----	----	----	6	13	12	----	.7	.0
Winnemucca	4,339	5	56	25.64	30.09	−.07	34.0	+5.4	53	12	42	13	6	26	28	32	28	79	1.22	+.2	15	8.1	ne.	25	sw.	14	8	3	20	6.9	7.9	.0
Modena	5,473	10	46	-----	30.12	+.02	32.2	+5.5	50	9	42	11	3	22	30	----	----	84	.42	−.4	13	7.4	w.	28	nw.	14	4	7	20	7.5	5.2	.0
Salt Lake City [2]	4,357	86	210	-----	-----	-----	32.6	+3.4	48	19	39	14	4	26	20	29	----	84	1.13	-----	8	4.9	nw.	27	nw.	14	7	8	16	----	7.4	.0
Grand Junction	4,602	60	68	25.48	30.15	+.09	32.0	+8.0	49	27	40	16	4	24	28	29	24	72	.77	+.2	12	5.1	se.	18	se.	24	7	7	17	6.6	7.2	.5
Northern Plateau							**32.0**	**+4.1**										**87**	**1.22**	**−0.4**										**8.0**		
Baker [2]	3,471	36	54	26.49	30.14	−.02	32.4	+7.5	49	11	39	11	2	25	25	29	27	87	.69	−.7	11	5.9	s.	17	s.	25	7	6	18	6.9	7.7	.0
Boise [1]	2,739	5	49	27.26	30.17	−.02	33.2	+3.4	48	27	40	14	3	26	27	31	29	84	1.23	-----	14	8.2	se.	38	se.	6	8	4	19	6.8	4.1	.0
Pocatello [1]	4,477	5	31	25.55	30.22	+.02	26.4	+1.7	42	18	35	1	3	18	27	25	23	87	.62	-----	12	6.8	sw.	34	s.	7	9	3	19	6.8	5.5	.0
Spokane [2]	1,929	101	110	28.01	30.10	−.02	32.0	+4.5	48	29	38	15	5	26	22	31	30	89	1.61	−.6	12	4.4	ne.	19	s.	18	1	7	23	8.7	8.1	.0
Walla Walla	991	57	65	29.01	30.11	−.04	34.7	+2.0	57	17	39	20	5	30	18	----	----	88	1.63	−.3	12	4.5	s.	19	se.	17	0	2	29	9.6	4.8	.0
Yakima	1,076	58	67	28.92	30.10	-----	33.0	+5.6	52	26	38	21	5	29	21	32	30	86	1.53	+.2	15	3.6	se.	12	ne.	8	2	2	27	9.2	6.3	.0
North Pacific Coast Region							**45.1**	**+5.1**										**82**	**5.45**	**−1.2**										**8.2**		
North Head	211	5	56	29.68	29.91	−.14	47.6	+5.5	62	10	52	35	1	43	16	44	41	80	7.61	−1.2	18	15.9	e.	63	s.	17	1	7	23	8.0	.0	.0
Seattle [2]	125	90	321	29.82	29.96	−.09	45.9	+6.4	60	9	51	29	2	40	20	42	39	82	5.16	+.2	17	8.0	se.	35	s.	30	2	6	23	8.1	T	.0
Tacoma	194	172	201	29.75	29.96	−.08	44.4	+5.6	58	9	50	28	2	39	18	----	----	---	4.32	−1.8	16	5.8	s.	25	s.	15	2	2	27	8.7	T	.0
Tatoosh Island	86	9	61	29.80	29.90	−.08	46.6	+5.4	59	10	50	37	5	43	12	44	41	82	10.07	−1.8	19	20.3	e.	59	s.	17	2	6	23	8.4	.0	.0
Medford [1]	1,329	29	58	28.58	30.02	-----	41.8	+3.9	61	8	50	24	3	34	30	40	37	83	2.15	−.6	16	-----	n.	----	----	----	2	3	26	7.8	.0	.0
Portland, Oreg. [2]	154	68	106	29.81	29.98	−.10	44.2	+4.8	58	17	49	27	2	39	17	39	37	85	5.24	−1.4	18	5.7	e.	19	e.	21	2	4	25	8.3	T	.0
Roseburg	510	45	76	29.42	29.98	−.12	45.4	+4.2	61	17	52	30	3	38	24	43	40	83	3.58	−1.7	20	3.5	s.	14	nw.	25	1	3	27	8.7	.0	.0
Middle Pacific Coast Region							**51.0**	**+4.0**										**79**	**10.38**	**+4.8**										**7.5**		
Eureka	60	72	88	29.93	30.00	−.10	51.6	+4.7	66	11	58	34	1	46	21	48	45	78	11.37	+4.3	19	8.3	se.	35	nw.	14	5	3	23	7.7	.0	.0
Redding [1]	722	20	34	29.27	30.05	-----	48.5	+3.2	71	10	54	32	5	43	25	44	40	76	16.12	+9.3	19	7.4	nw.	28	s.	23	5	4	22	7.7	T	.0
Sacramento [2]	66	92	115	29.99	30.06	−.06	49.9	+4.1	64	10	55	36	2	44	21	48	46	84	5.78	+2.1	16	7.7	se.	35	se.	6	7	4	20	7.4	.0	.0
San Francisco	155	112	132	29.87	30.04	−.07	54.0	+4.1	67	10	58	44	1	49	19	50	47	78	8.24	+3.7	16	6.3	se.	30	se.	23	5	7	19	7.3	.0	.0
South Pacific Coast Region							**55.0**	**+3.5**										**74**	**1.93**	**−0.4**										**6.5**		
Fresno [1]	327	89	35	29.73	30.09	−.01	49.8	+3.6	66	9	58	33	1	42	27	48	45	82	1.56	−.2	13	4.3	se.	19	ne.	20	2	7	22	8.0	.0	.0
Los Angeles	338	223	250	29.70	30.06	−.02	57.6	+3.6	73	18	65	45	15	50	24	51	44	64	2.21	−.9	10	7.5	e.	26	e.	10	10	8	13	5.4	.0	.0
San Diego	87	62	70	29.96	30.06	−.01	57.6	+3.3	71	8	66	45	19	50	24	52	49	76	2.03	0	10	5.3	ne.	20	s.	24	11	2	18	6.2	.0	.0
West Indies																																
San Juan, P. R.	82	10	54	29.93	30.02	-----	75.2	+.2	86	26	80	67	9	70	17	----	----	---	2.29	−1.9	16	9.8	e.	26	n.	16	12	12	7	5.0	.0	.0
Panama Canal																																
Balboa Heights	118	6	92	29.77	29.86	-----	80.4	+.5	92	18	89	69	13	72	21	72	71	81	.87	−.2	3	9.3	nw.	3	nw.	31	7	24	0	4.7	----	----
Cristobal	36	6	97	29.85	29.88	-----	81.5	.0	87	25	85	73	6	78	12	74	72	75	3.25	−.2	13	13.9	n.	3	n.	10	0	15	16	7.1	----	----
Alaska																																
Fairbanks	454	11	87	-----	-----	-----	----	----	----	----	----	----	----	----	----	----	----	---	-----	-----	----	-----	----	----	----	----	----	----	----	----	----	----
Juneau	80	96	116	29.64	29.73	-----	31.2	+3.8	46	12	36	5	26	26	26	29	24	73	6.44	-----	18	9.1	s.	32	ne.	23	4	1	26	8.3	11.4	.0
Nome	22	5	59	-----	-----	-----	----	----	----	----	----	----	----	----	----	----	----	---	-----	-----	----	-----	----	----	----	----	----	----	----	----	----	----
Hawaiian Islands							**73.2**	**+2.3**										**72**	**0.47**	**−3.3**										**3.7**		
Honolulu	38	86	100	29.95	29.99	-----	73.2	+2.3	82	3	78	63	16	68	14	66	62	72	.47	−3.3	5	8.6	ne.	28	ne.	2	17	12	2	3.7	.0	.0

[1] Data are airport records.
[2] Barometric and hygrometric data from airport, other data from city records.
[3] Observations taken bihourly.
[4] Pressure not reduced to a mean of 24 hours.
[5] Barometric, hygrometric and temperature records from airport, other data from city office records.
[6] Wind, and clear, partly cloudy, and cloudy data, from city office records, other data from airport records.

NOTE.—Except as indicated by notes 1, 2, 5, and 6, data in table—are city office records.

SEVERE LOCAL STORMS

[Compiled by Mary O. Souder from reports submitted by Weather Bureau officials]

[The table herewith contains such data as has been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
California,[1] southern San Joaquin Valley and adjoining foothills.	8–10			1	$250,000	Wind	Much damage to buildings, trees and oil derricks. Flood conditions caused many rural schools to close. Heavy damage was reported to crops by the wind which ripped out thousands of acres of wheat. Citrus trees had their leaves stripped, in many cases. Numerous highways leading to Los Angeles were blocked and, in the vicinity of Santa Barbara, rail travel delayed for several hours.
Rio Grande Valley, Tex.[1]	11					do	Loss in citrus fruits. Reports indicate that as much as 20 percent of the grapefruit crop on the trees was blown to the ground and an equal amount remaining on the trees will be unfit for shipment in fresh-fruit channels.
Eureka, Calif.	14	1:32 a. m.				do	Several fishing vessels sunk or damaged; number of plate-glass windows broken.
Morgan City, La.	14	2:30 p. m.	800	0	500	Tornado	No details.
New Mexico[1]	15					Snow, rain and wind.	Wind reaching a velocity of 75 miles an hour was recorded through Guadalupe Pass in the Guadalupe Mountains, along southern New Mexico-Texas line. In northern New Mexico snow fell over higher altitudes reaching as far south as Santa Fe. About 10 to 15 inches of snow reported in the Taos Questa area near the Colorado line.
Sabine Pass, Tex.	16	3 a. m.			1,000	Straight-line-wind.	Property damaged.
Boyce, Tioga and Alexandria, La.	16	11:30 p. m.		1		Thunderstorm and hail.	Man killed by lightning; trees uprooted; power lines damaged.
Atlantic City, N. J.,[1] and vicinity.	16					Wind and rain	Rainfall of 1.78 inches recorded up to 7:30 p. m., with an extreme wind velocity of 58 miles per hour shortly after noon. Bus and automobile traffic somehwat delayed.
Virginia, western portion	16				3,500	Glaze	Damage to poles and wires.
Opelousas, La., vicinity of	26	4:30 a. m.		0		Tornado	5 Negroes injured; 2 houses demolished and 2 others damaged.

[1] From press reports.

SOLAR RADIATION AND SUNSPOT DATA FOR JANUARY 1941

SOLAR RADIATION OBSERVATIONS

By HELEN CULLINANE

Measurements of solar radiant energy received at the surface of the earth are made at 9 stations maintained by the Weather Bureau and at 10 cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at two Weather Bureau stations (Madison, Wis.; Lincoln, Nebr.) and at the Blue Hill Observatory at Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau station at Madison and at Blue Hill Observatory.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data obtained, up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Lincoln the observations are made with the Marvin pyrheliometer; at Madison and Blue Hill they are obtained with a recording thermopile, checked by observations with a Smithsonian silver-disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 7:30 a. m. and at 1:30 p. m. (75th meridian time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures from normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Total solar and sky radiation was considerably deficient at Washington, Madison, Lincoln, Chicago, Fresno, La Jolla, Riverside, and Blue Hill, and considerably above normal at New Orleans and New York.

Normal incidence measurements at Madison, Wis., the only station reporting, showed a considerable excess in radiation.

No polarization measurements were made at either Madison or Blue Hill, due to snow cover and extreme cold.

TABLE 1.—*Solar radiation intensities during January 1941*

[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

Date	Sun's zenith distance										
	7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	1:30 p. m.
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Jan. 3	2.26			1.26							2.62
Jan. 18	1.12	1.11	1.19	1.34		1.76					1.29
Jan. 30	3.30	.87	.99	1.22		1.81					3.63
Jan. 30	2.16	1.06	1.22	1.31							2.87
Means		**1.01**	**1.13**	**1.28**		(1.78)					
Departures		**+.06**	**+.07**	**+.08**		**+.12**					

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

[Gram-calories per square centimeter]

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Cambridge	Twin Falls	La Jolla	New Orleans	Riverside	Blue Hill	Albuquerque	Friday Harbor	Newport
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 1	182	117	132	111	160	106	147	164	220	176	191	121	279	81	161
Jan. 8	203	117	163	78	172	170	174	189	198	267	192	161	240	80	191
Jan. 15	144	109	114	97	115	182	127	146	285	263	261	119	310	87	135
Jan. 22	98	140	139	49	132	172	162	188	201	271	189	144	251	111	164
DEPARTURES FROM WEEKLY NORMALS															
Jan. 1	+13	−10	−39	+26	+51	−39	+7	+11	−9	+3	−61	−21	+28	+10	+4
Jan. 8	+52	−13	−19	−1	+63	+6	+19	+31	−46	+55	−100	+7	−27	+2	+22
Jan. 15	−12	−43	−78	−1	0	+1	−20	−24	+16	+39	−43	−44	+32	−6	−21
Jan. 22	−78	−43	−89	−68	−20	−38	−11	+5	−78	+61	−78	−20	−29	+17	−3
ACCUMULATED DEPARTURES ON JANUARY 28, 1941															
	−175	−763	−1,575	−308	+658	−490	−35	+161	−819	+1,106	−1,974	−546	+28	+161	+14

LATE DATA FOR FAIRBANKS, ALASKA

Week beginning—	Total solar radiation	Departures
Dec. 3	7	−1
Dec. 10	3	−2
Dec. 17	13	+6
Dec. 24	5	−2

Total departure for the year, +5,243; percentage departure, +6.1.

POSITIONS, AREAS, AND COUNTS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory.] All measurements and spot counts were made at the Naval Observatory from plates taken at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's hemisphere. For each day, under longitude, latitude, area of spot or group, and spot count, are included assumed longitude of center of the disk, assumed latitude of center on the disk, total area of spots and groups, and total spot count.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1941	h m		°	°	°	°				
Jan. 1	13 33	7096	−46	333	+2	47	6	1	G	U. S. Naval.
		7095	−43	336	+8	45	73	5		
		7094	−41	338	+15	45	66	8		
		7097	−40	339	+9	41	48	2		
		7093	−39	340	+18	44	36	1		
		7094	−38	341	+13	41	97	8		
		7092	−15	4	−8	16	145	7		
		7098	−14	5	+18	25	12	1		
				(19)	(−3)		483	33		
Jan. 2	10 47	7096	−33	334	+2	33	24	6	VG	Mt. Wilson.
		7095	−31	336	+8	33	73	7		
		7094	−29	338	+15	34	61	8		
		7097	−28	339	+9	31	48	9		
		7093	−27	340	+18	34	36	5		
		7094	−26	241	+13	31	48	16		
		7092	−3	4	−8	6	48	9		
		7098	−2	5	+18	21	12	1		
				(7)	(−3)		350	61		
Jan. 3	11 3	7095	−17	337	+8	20	121	8	VG	Do.
		7094	−16	338	+16	25	121	8		
		7097	−14	340	+9	19	97	12		
		7090	−14	340	−15	19	12	2		
		7094	−13	341	+13	20	97	13		
		7093	−13	341	+19	25	24	3		
		7092	+14	8	−8	15	24	5		
		7098	+17	11	+17	27	12	3		
				(354)	(−3)		508	54		
Jan. 4	11 14	•	−22	318	−11	23	24	3	G	U. S. Naval.
		•	−7	333	−14	13	12	2		
		7094	−4	336	+16	20	145	6		
		7095	−4	336	+9	13	73	9		
		•	−3	337	+24	27	12	4		
		7094	−2	338	+14	18	73	8		
		7097	−1	339	+9	12	48	4		
		7093	−1	339	+20	23	36	1		
		7098	+29	9	+19	36	73	4		
				(340)	(−3)		496	41		

See footnotes at end of table.

POSITIONS, AREAS, AND COUNTS OF SUN SPOTS—Con.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1941	h m		°	°	°	°				
Jan. 5	12 48	7093	+10	336	+19	25	145	8	F	U. S. Naval.
		7095	+11	337	+10	18	121	5		
		7097	+13	339	+11	20	48	5		
		7094	+15	341	+15	24	97	6		
		7092	+33	359	−8	33	194	9		
		7098	+43	9	+18	49	73	2		
				(326)	(−4)		678	35		
Jan. 6	11 56	•	−66	248	+21	70	12	1	VG	Do.
		7093	+23	337	+18	31	121	13		
		7095	+25	339	+10	29	97	8		
		7097	+27	341	+11	31	48	7		
		7094	+29	343	+15	35	97	9		
		7092	+46	0	−9	46	364	10		
		7098	+57	11	+17	60	12	1		
				(314)	(−4)		751	49		
Jan. 7	13 1	8002	−84	216	+11	84	194	1	VG	Do.
		8001	−63	237	−10	63	158	10		
		7093	+37	337	+17	42	36	4		
		8000	+39	339	+5	40	121	14		
		7095	+39	339	+10	41	36	10		
		7097	+42	342	+11	44	24	5		
		7094	+43	343	+15	47	48	6		
		7092	+61	1	−9	61	364	10		
		7098	+68	8	+17	70	12	1		
				(300)	(−4)		993	61		
Jan. 8	12 56	8002	−70	217	+11	72	170	1	G	Do.
		8001	−49	238	−10	49	170	7		
		•	+42	329	+9	44	24	7		
		8000	+52	339	+5	53	48	5		
		7095	+53	340	+10	56	12	1		
		7097	+56	343	+11	58	12	3		
		7094	+56	343	+14	59	12	3		
		7092	+75	2	−9	75	364	7		
				(287)	(−4)		812	34		
Jan. 9	12 14	8002	−56	218	+7	57	97	1	VP	Do.
		8001	−35	239	−10	36	121	3		
				(274)	(−4)		218	4		
Jan. 10	12 1	8007	−72	189	−4	72	24	3	VG	Do.
		8002	−43	218	+11	46	97	2		
		8001	−21	240	−10	22	170	17		
		•	+17	278	+19	23	12	1		
		8003	+54	315	+3	54	170	13		
				(261)	(−4)		473	36		
Jan. 11	10 32	8007	−58	191	−4	58	24	3	G	Do.
		8002	−29	220	+11	32	97	1		
		8001	−8	241	−10	11	73	9		
		8005	+6	255	−7	6	24	4		
		8004	+45	294	−10	45	12	1		
		8003	+68	317	+3	69	158	9		
				(249)	(−4)		388	27		

POSITIONS, AREAS, AND COUNTS OF SUN SPOTS—Con.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1941	h m		°	°	°	°				
Jan. 12	11 15	8007	−45	190	−3	45	24	8	VG	Mt. Wilson.
		8008	−35	200	+13	40	6	2		
		8002	−15	220	+11	21	97	1		
		8001	+3	238	−7	4	24	5		
		8001	+8	243	−9	10	48	8		
		8006	+8	243	+10	16	6	3		
		8004	+53	288	−10	53	6	1		
		8003	+82	317	+3	82	97	5		
				(235)	(−4)		308	33		
Jan. 13	11 19	8007	−31	191	−3	31	97	7	G	U. S. Naval.
		8002	−2	220	+11	15	73	1		
		8001	+21	243	−10	22	24	4		
				(222)	(−4)		194	12		
Jan. 14	12 1	8007	−18	190	−3	19	24	4	G	Mt. Wilson.
		8002	+12	220	+11	20	61	1		
		8001	+34	242	−12	36	24	4		
				(208)	(−5)		109	9		
Jan. 15	11 23	8009	−67	128	−25	68	12	1	G	Do.
		8007	−4	191	−2	5	6	3		
		8008	+5	200	+10	15	12	5		
		8002	+25	220	+11	30	61	1		
				(195)	(−5)		91	10		
Jan. 16	11 17	8010	−76	106	+14	77	145	1	F	Do.
		8008	+20	202	+10	25	24	2		
		8002	+39	221	+10	42	61	1		
				(182)	(−5)		230	4		
Jan. 17	11 25	8011	−65	104	−12	65	12	2	VG	Do.
		8010	−62	107	+14	65	194	1		
		8002	+51	220	+12	54	48	1		
				(169)	(−5)		254	4		
Jan. 18	11 5	8011	−51	105	−12	52	12	5	VG	Do.
		8010	−49	107	+13	51	194	1		
		8012	−40	116	−7	40	24	9		
		8002	+65	221	+11	67	6	2		
				(156)	(−5)		236	17		
Jan. 19	12 17	8010	−35	107	+12	40	218	7	F	U. S. Naval.
		8012	−25	117	−6	25	24	6		
				(142)	(−5)		242	13		
Jan. 20	11 2	8010	−21	109	+12	27	206	4	F	Do.
		8012	−12	118	−6	12	109	5		
				(130)	(−5)		315	9		
Jan. 21	13 21	(*)	−27	88	−22	32	12	3	VG	Do.
		(*)	−14	101	−12	15	12	2		
		8010	−9	106	+8	16	24	5		
		8010	−8	107	+12	19	206	1		
		8012	+2	117	−6	2	291	15		
				(115)	(−5)		545	26		
Jan. 22	13 17	8013	+1	103	−12	7	61	9	VG	Do.
		8010	+7	109	+12	18	194	1		
		8012	+16	118	−6	16	279	17		
				(102)	(−5)		534	27		
Jan. 23	11 6	(*)	−60	30	+9	62	12	2	G	Do.
		8013	+13	103	−12	15	121	12		
		8010	+18	108	+12	25	194	1		
		8012	+28	118	−6	28	279	17		
				(90)	(−5)		606	32		
Jan. 25	11 43	8015	−82	342	−16	82	97	4	VG	Mt. Wilson.
		8014	−73	351	+13	77	582	16		
		8013	+39	103	−12	39	48	15		
		8010	+45	109	+12	50	194	10		
		8012	+53	117	−6	53	24	8		
		8012	+60	124	−7	60	97	5		
				(64)	(−6)		1,042	58		
Jan. 27	12 30	8016	−68	329	−3	69	18	1	P	Do.
		8015	−55	342	−11	55	61	2		
		8014	−45	352	+12	50	776	15		
		8013	+66	103	−14	66	24	1		
		8010	+75	112	+12	78	194	1		
				(37)	(−6)		1,073	20		

POSITIONS, AREAS, AND COUNTS OF SUN SPOTS—Con.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1941	h m		°	°	°	°				
Jan. 28	12 56	8019	−88	295	+10	88	48	1	VG	U. S. Naval.
		8018	−83	300	−12	83	388	1		
		8016	−55	328	−2	56	133	10		
		8015	−41	342	−11	41	36	6		
		8014	−31	352	+12	36	582	45		
		8017	+17	40	−3	18	48	13		
				(23)	(−6)		1,235	76		
Jan. 29	11 58	8018	−79	292	−12	79	133	5	VG	Do.
		8019	−73	298	+11	76	97	4		
		8018	−69	302	−12	69	339	7		
		8018	−65	306	−9	65	12	1		
		8016	−43	328	−3	44	24	7		
		8016	−39	332	−2	40	145	2		
		8015	−28	343	−11	28	24	9		
		8014	−20	351	+12	26	582	42		
		8017	+30	41	−2	31	97	12		
				(11)	(−6)		1,453	89		
Jan. 30	12 9	8018	−60	298	−12	60	400	13	G	Do.
		8019	−60	298	+10	63	97	2		
		8016	−30	328	−2	31	24	3		
		8016	−27	331	−2	28	145	1		
		8015	−15	343	−11	16	12	3		
		8014	−6	352	+12	19	582	36		
		8017	+39	37	−3	40	24	5		
		8017	+48	46	−1	49	73	3		
				(358)	(−6)		1,357	66		
Jan. 31	14 36	8018	−50	293	−12	50	97	6	G	Do.
		8019	−44	299	+9	45	61	1		
		8018	−39	304	−12	40	218	3		
		8016	−10	333	−1	12	145	1		
		8015	−4	339	−10	5	12	3		
		8014	+9	352	+12	20	533	29		
		8017	+53	36	−1	54	24	3		
		8017	+64	47	−1	65	36	1		
				(343)	(−6)		1,126	47		

Mean daily area for 29 days ------ = 590.

*=Not numbered.
VG=very good; G=good; F=fair; P=poor; VP=very poor.

PROVISIONAL RELATIVE SUNSPOT NUMBERS FOR DECEMBER 1940

Based on observations at Zurich and Locarno. Prof. W. Brunner, Eidgen. Data furnished through the courtesy of Sternwarte, Zurich

December 1940	Relative numbers	December 1940	Relative numbers	December 1940	Relative numbers
1	*a 29	11	a 157	21	*40
2	*24	12	*134	22	----------
3	*Ec 32	13	Wac 158	23	27
4	Ec 45	14	ad 149	24	Mac 58
5	*d 69	15	*a 122	25	*51
6	*63	16	----------	26	*48
7	a 89	17	67	27	*a 42
8	Eacd 82	18	60	28	d 34
9	Maacc 108	19	29	29	55
10	Ec 142	20	Ec 37	30	49
				31	*40

Mean, 29 days=70.3

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group through the central meridian.
c=New formation of a group developing into a middle-sized or large center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central-circle zone.
d=Entrance of a large or average-sized center of activity on the east limb.
* Observed at Locarno.

DESCRIPTION OF CHARTS

Chart I. *Temperature departures and wind roses for selected stations.*—Based on data contained in table 2, this chart presents the departures of the monthly mean surface temperatures from the monthly normals. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. Charts of monthly surface temperature departures in the United States were first published in the MONTHLY WEATHER REVIEW for July 1909, and continued thereafter, but smaller charts appear in W. B. *Bulletin U* for 1873 to June 1909, inclusive. An innovation has been made in this chart, beginning January 1939. The selected wind rose data formerly published as chart VII have been transferred to this chart. The wind roses are based on hourly percentages by months for 28 selected Weather Bureau stations.

Chart II. *Tracks of centers of* ANTICYCLONES; and

Chart III. *Tracks of centers of* CYCLONES.—The roman numerals show the chronological order of the centers. The figures within the circles show the days of the month, the location indicated being that at 7:30 a. m., 75th meridian time. Within each circle is also an entry of the last three figures of the highest barometric reading (chart II) or the lowest reading (chart III) reported at or near the center at that time, in both cases as reduced to sea level and standard gravity. The intermediate 7:30 p. m. locations are indicated by dots. The inset map on chart II shows the departure of monthly mean pressure from normal and the inset on chart III shows the change in mean pressure from the preceding month.

The use of a new base map for charts II and III began with the January 1930 issue. Charts IV, V, and VI are based on data found in table 2.

Chart IV. *Percentage of clear sky between sunrise and sunset.*—The average cloudiness at each regular Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the night hours.

Chart V. *Total precipitation.*—The scales of shading with appropriate lines show the distribution of the monthly precipitation according to reports from both regular and cooperative observers. The inset on this chart shows the departure of the monthly totals from the corresponding normals, as indicated by the reports from the regular stations.

Chart VI. *Isobars at sea level and isotherms at surface, prevailing winds.*—The pressures have been reduced to sea level and standard gravity by the method described by Prof. Frank H. Bigelow in the REVIEW for January 1902, **30:** 13–16. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of 7:30 a. m. and 7:30 p. m. readings at stations taking two observations daily, and to the 7:30 a. m. or the 7:30 p. m. observation at stations taking but a single observation.

The diurnal corrections so applied, except for stations established since 1901, will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, table 27, pages 140–164.

The sea-level temperatures are now omitted and average surface temperatures substituted. The isotherms cannot be drawn in such detail as might be desired, for data from only the regular Weather Bureau stations are used.

The prevailing wind directions are determined from hourly observations at almost all the stations. A few stations determine their prevailing directions from the daily or twice-daily observations only.

Chart VII. *Total snowfall.*—This is based on the reports from regular and cooperative observers and shows the depth in inches of the snowfall during the month. In general, the depth is shown by lines connecting places of equal snowfall, but in special cases figures also are given. This chart is published only when the snowfall is sufficiently extensive to justify its preparation. The inset on this chart, when included, shows the depth of snow on the ground at 7:30 p. m. of the Monday nearest the end of the month and is a copy of the snow chart appearing in the Snow and Ice Bulletin for that week. Generally, the publication of the Weekly Snow and Ice Bulletin commences about the middle of December and continues to near the close of March.

Charts VIII, IX, X, and XI show the monthly mean barometric pressures in millibars, mean temperatures in degrees Centigrade, and resultant-wind directions and forces in Beaufort Scale, for 1.5, 3, 5, and 10 kilometers, respectively. However, the mean pressures given on chart VIII are reduced from 1.5 kilometers to an altitude of 5,000 feet (1,524 meters).

The mean pressures and temperatures, based on observations obtained by radiosondes and airplanes, are shown on charts VIII, IX, and X, for 1.5, 3, and 5 kilometers, respectively, while those based on radiosondes only are given on chart XI for 10 kilometers. All Weather Bureau radiosonde observations are made at 12:30 a. m., 75th meridian time.

Resultant-wind directions and forces for the month, as shown on charts VIII and IX for 1.5 and 3 kilometers, respectively, are based on observations taken at 5 a. m., 75th meridian time, but the winds given on charts X and XI (5 and 10 kilometers, respectively), are based on the 5 p. m., 75th meridian time, observations, which, as a rule, reach much higher altitudes.

Chart XII represents a mean isentropic chart which has been developed in accordance with methods used by the Division of Research and Education of the U. S. Weather Bureau. This has been described in detail in the January 1939 issue of the MONTHLY WEATHER REVIEW. It is based on the mean free-air data from radiosonde, airplane, and pilot-balloon stations. This chart is temporarily discontinued with this issue of the MONTHLY WEATHER REVIEW since it is considered of questionable value during winter months.

Chart XIII shows the mean monthly altitudes (in kilometers) and weighted mean temperatures (° C.) of the tropopauses for each radiosonde station, classified in ten-degree intervals of potential temperature (° A). This chart is prepared each month from data shown in table 4 under "Aerological Observations."

Charts XIV, XV, etc.—North Atlantic weather maps for particular days.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, January 1941

Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, January 1941

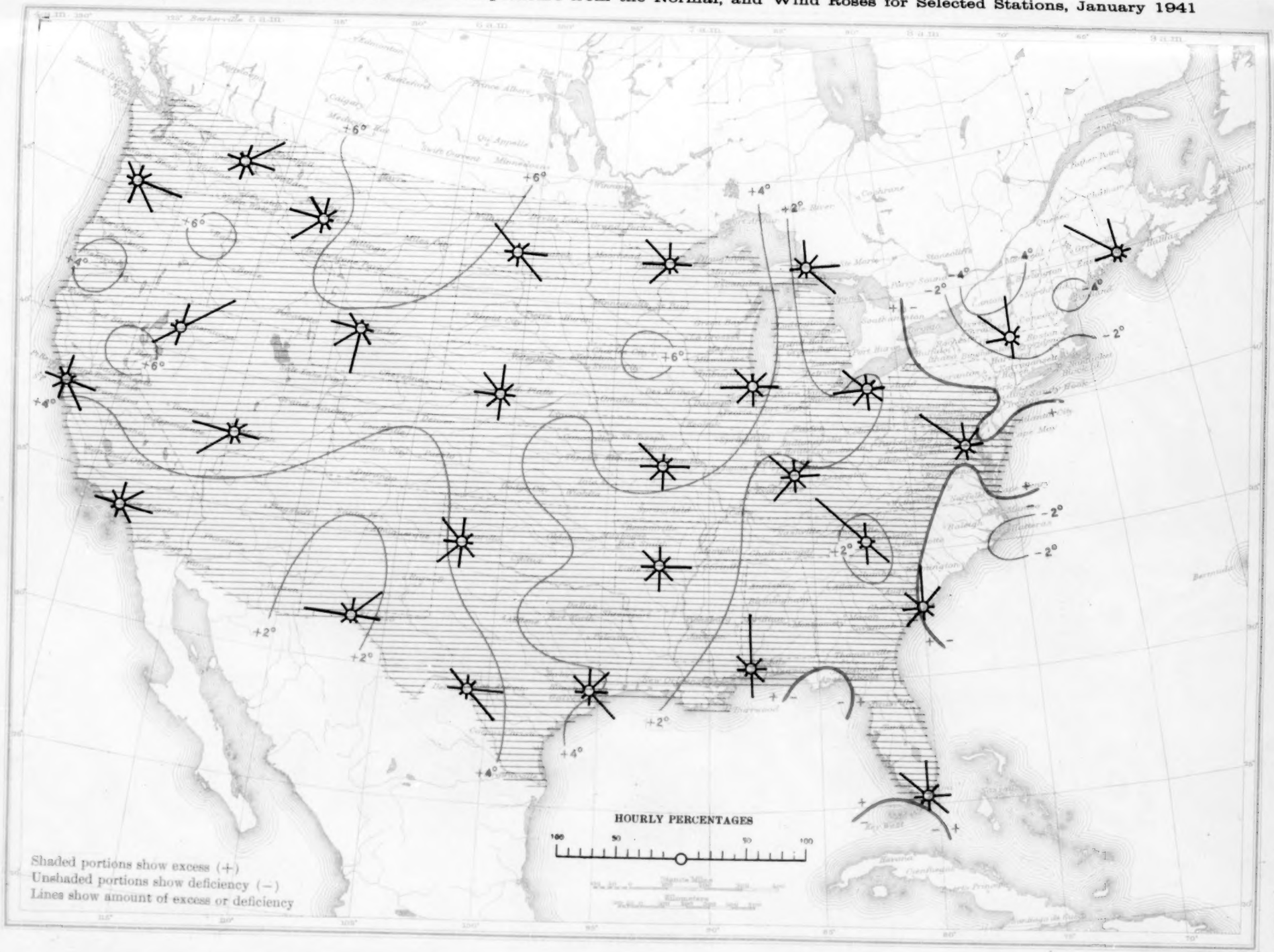
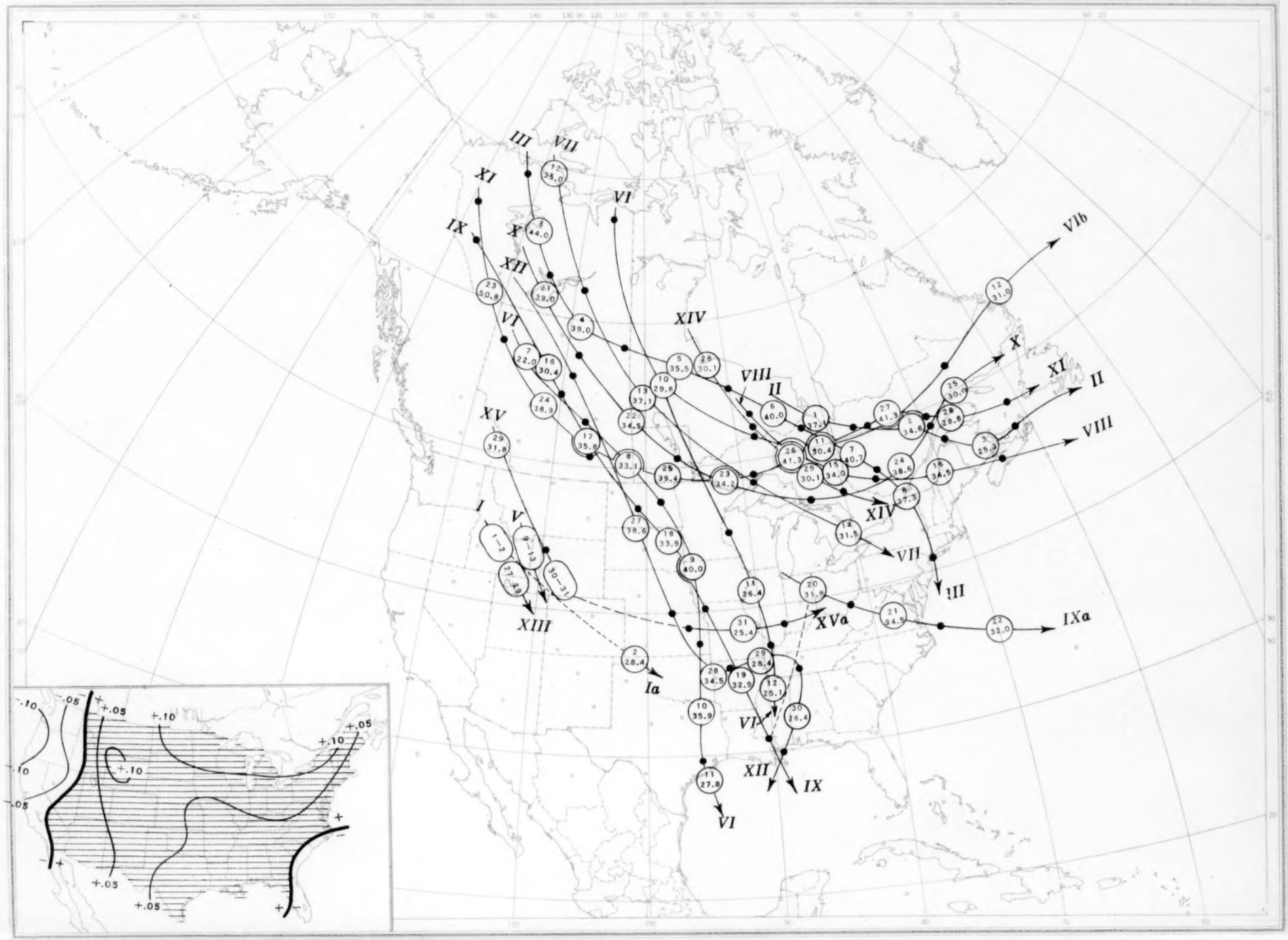


Chart I. Departure (°F.) of the Mean Temperature from the Normal and Wind Roses for Selected Stations, January 1941

Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, January 1941

Chart II. Tracks of Centers of Anticyclones, January 1941. (Inset) Departure of Monthly Mean Pressure from Normal

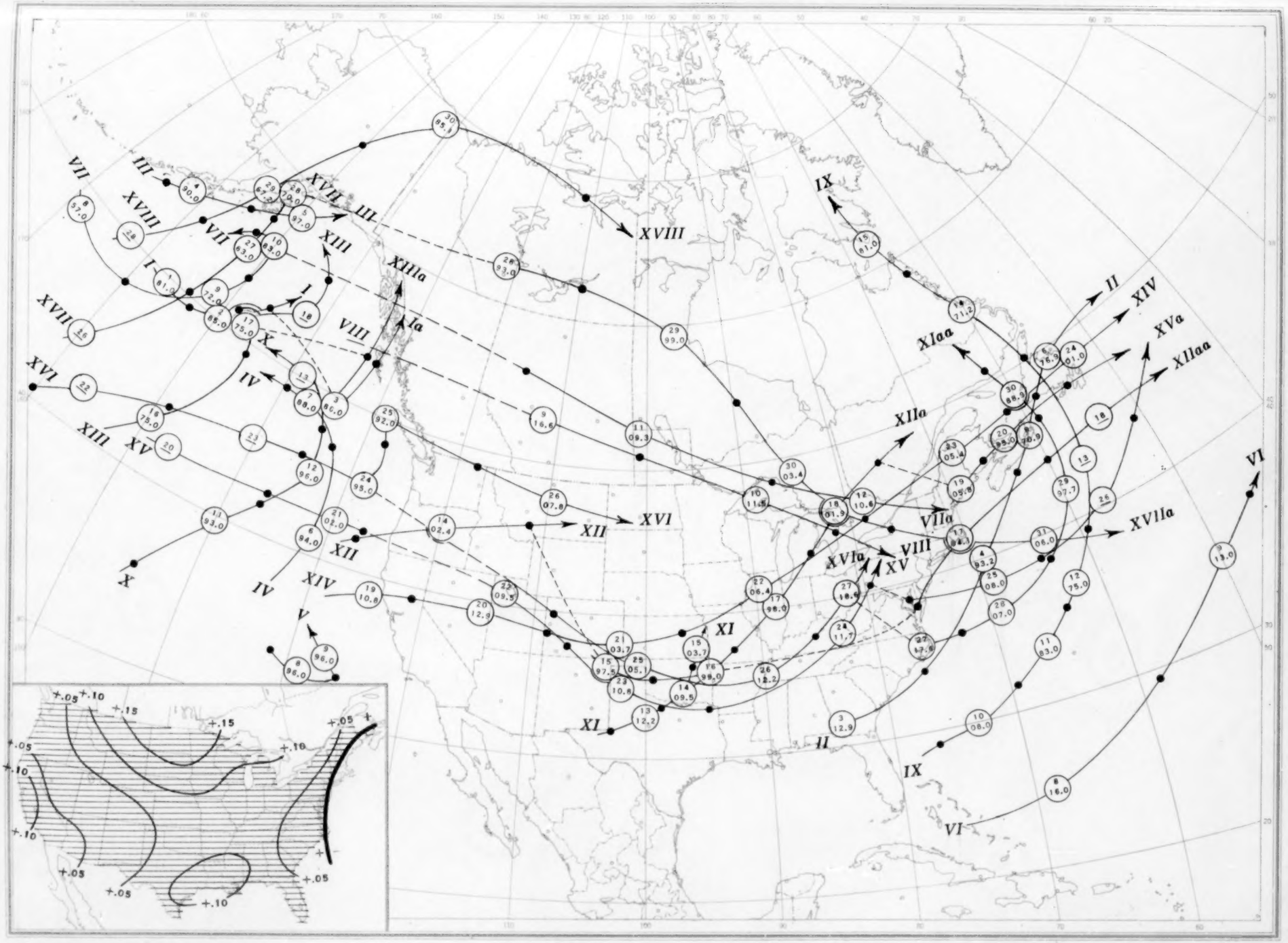


Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, January 1941. (Inset) Change in Mean Pressure from Preceding Month

Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, January 1941. (Inset) Change in Mean Pressure from Preceding Month



Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, January 1941

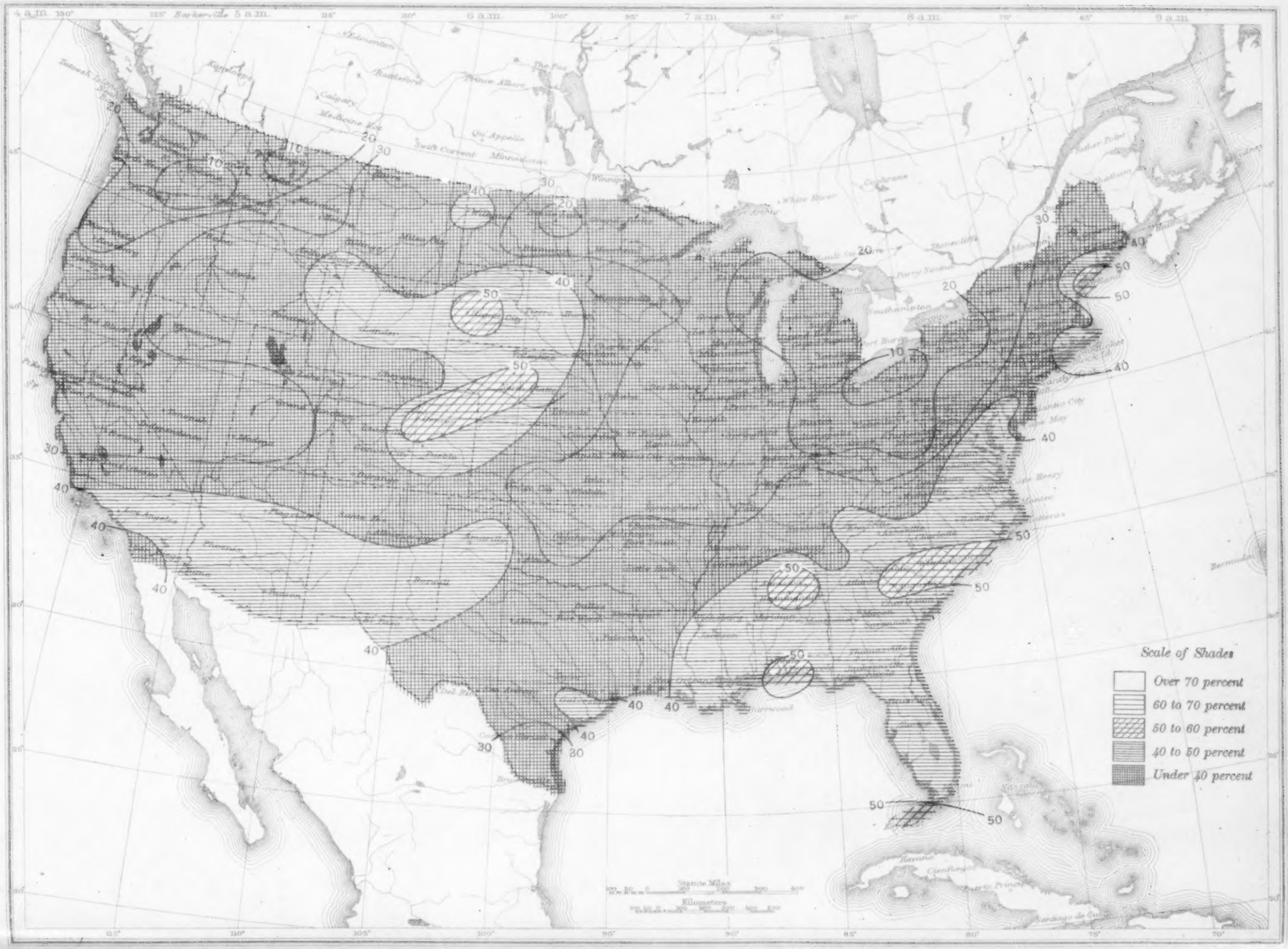


Chart V. Total Precipitation, Inches, January 1941. (Inset) Departure of Precipitation from Normal

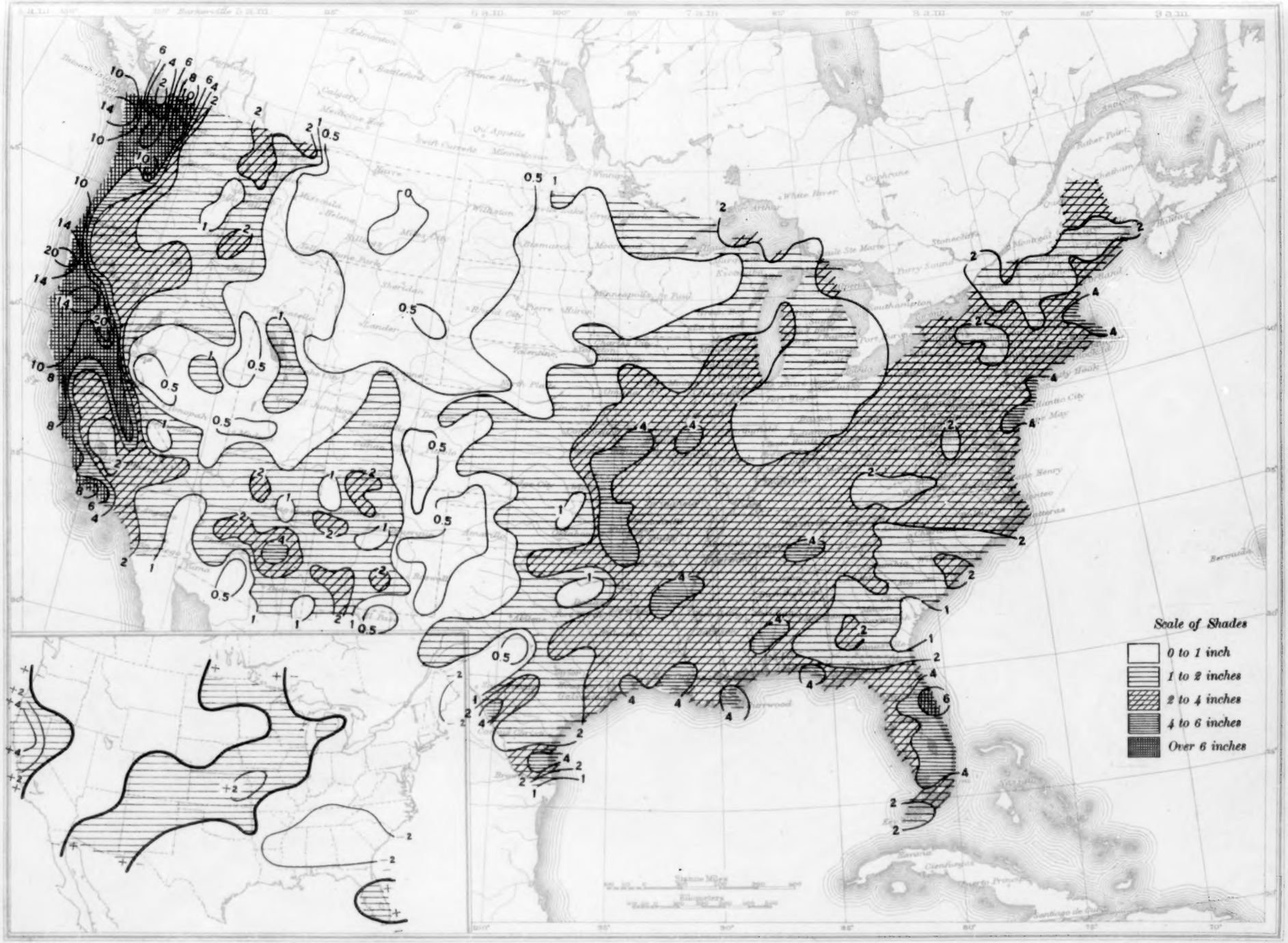


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, January 1941

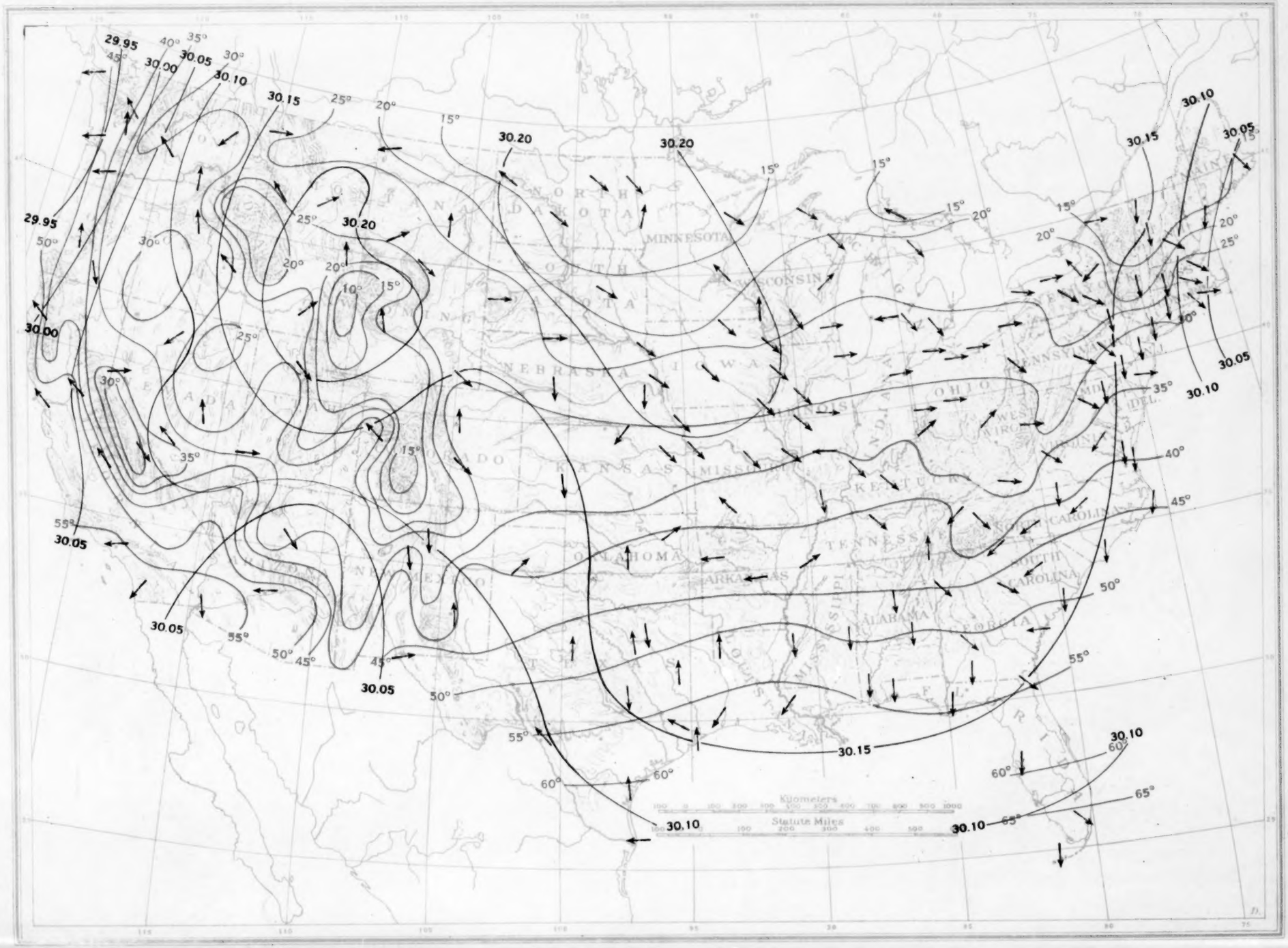


Chart VII. Total Snowfall, Inches, January 1941. (Inset) Depth of Snow on the Ground at 7:30 p.m., Monday, January 27, 1941

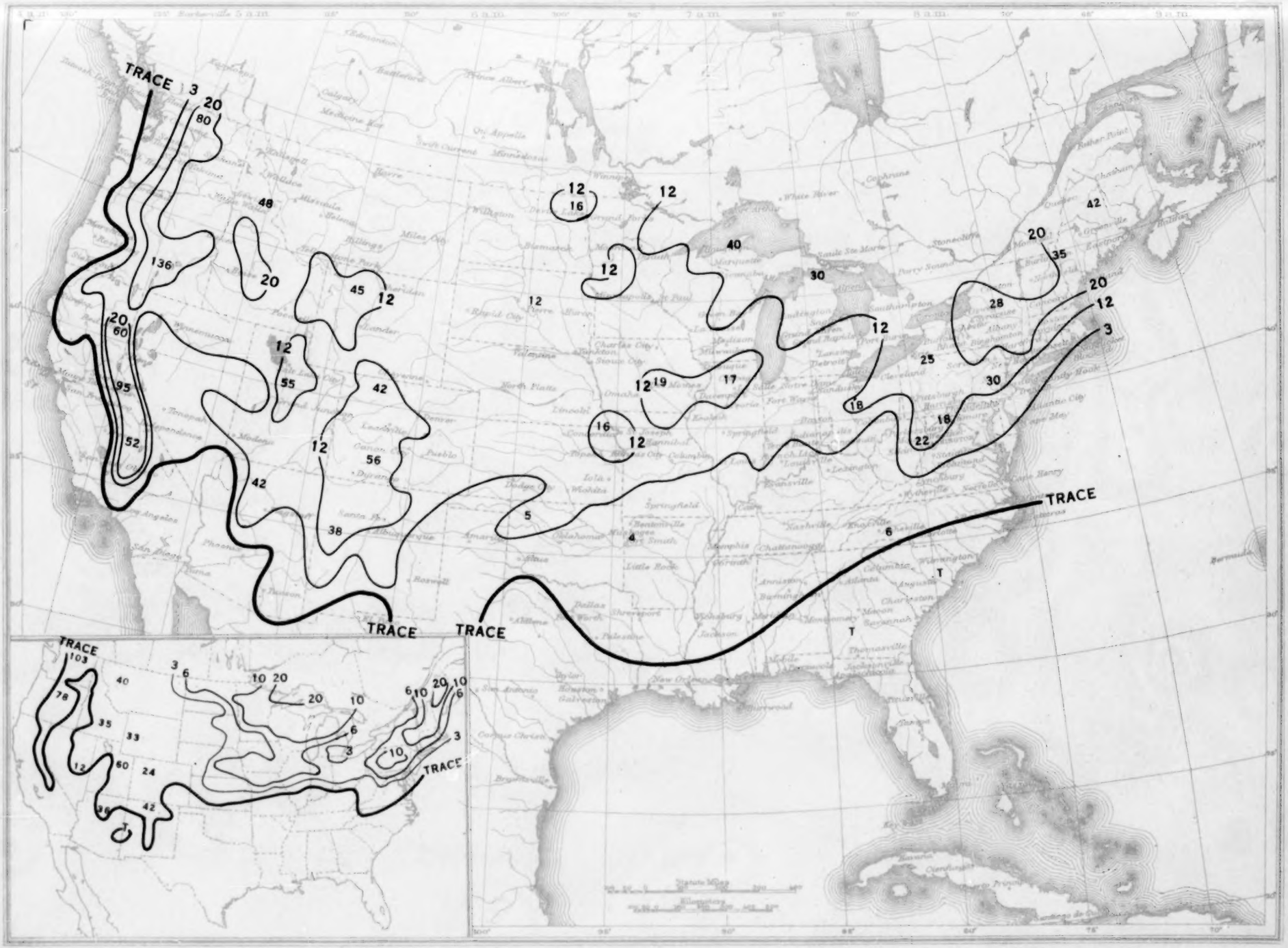


Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters (m. s. l.) January 1941

Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters (m. s. l.) January 1941

Isobars and isotherms based on radiosonde observations at 12:30 a. m. (E. S. T.) and winds based on pilot-balloon observations at 5:00 a. m. (E. S. T.).

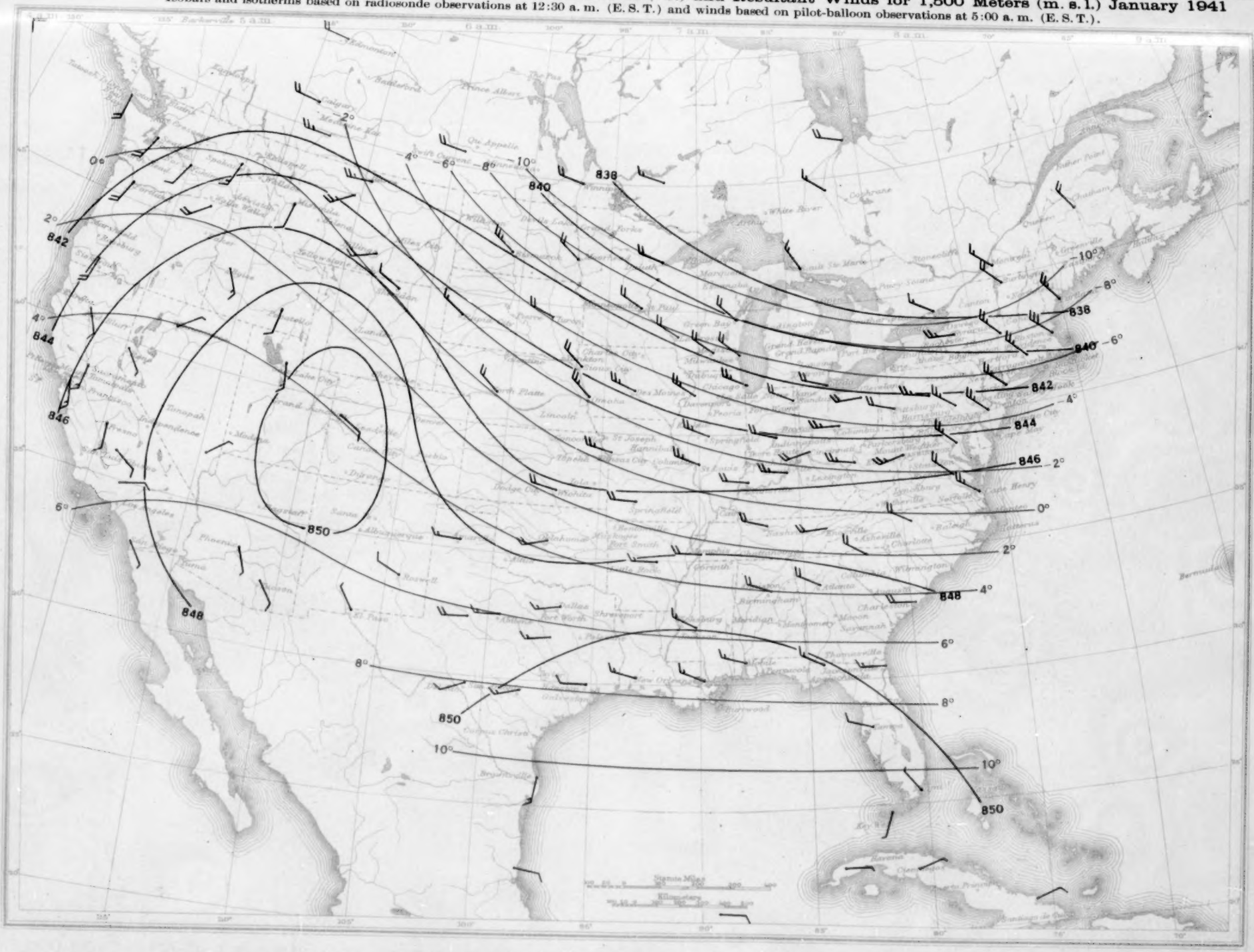


Chart IX. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T) and Resultant Winds 5:00 a.m. (E.S.T.) for 3,000 Meters (m.s.l.) January 1941

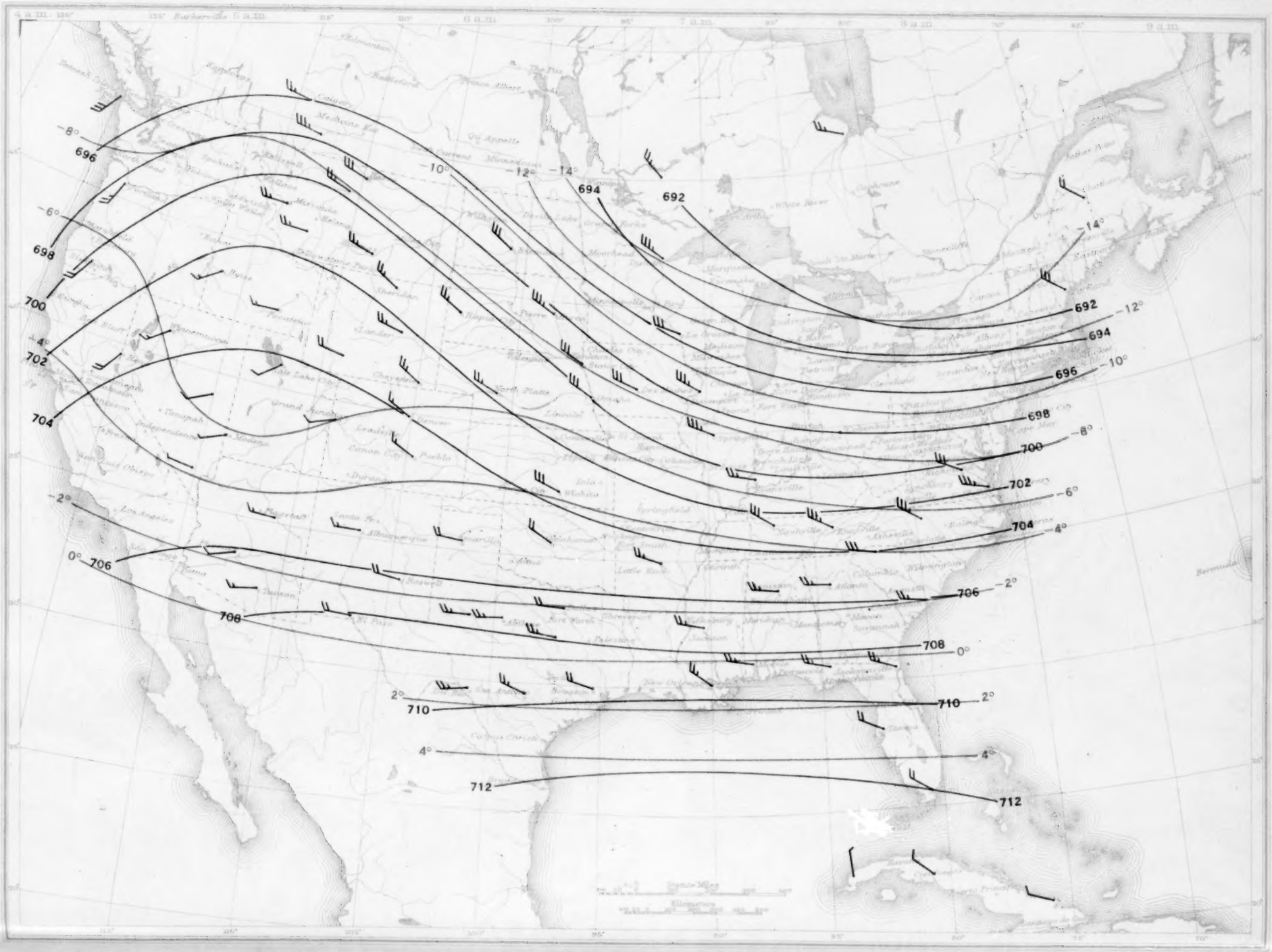


Chart X. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T.) and Resultant Winds 5:00 p.m. (E.S.T.) for 5,000 Meters (m.s.l.) January 1941

Chart X. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T.) and Resultant Winds 5:00 p.m. (E.S.T.) for 5,000 Meters (m.s.l.) January 1941

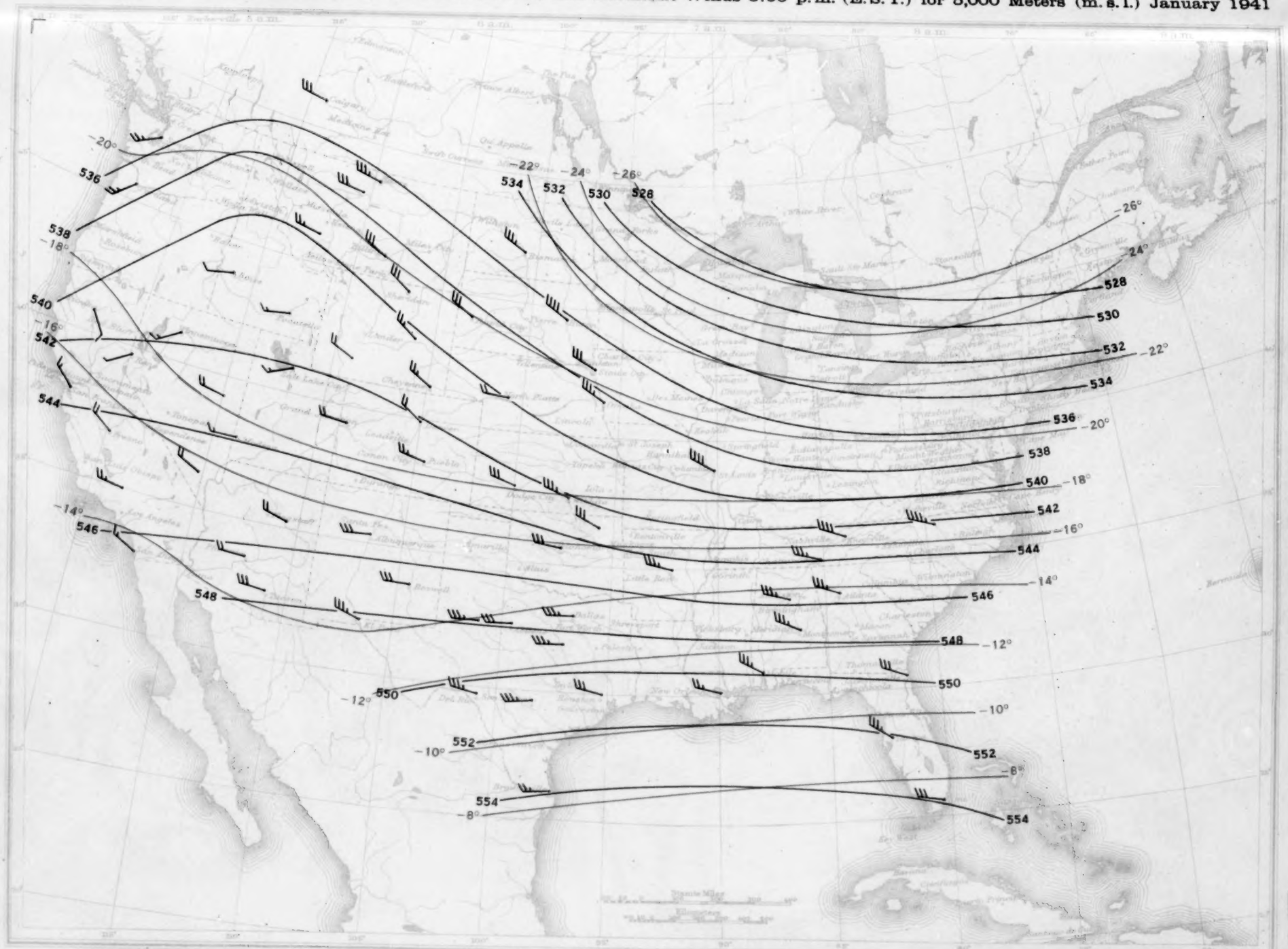


Chart XI. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T.) and Resultant Winds 5:00 p.m. (E.S.T.) for 10,000 Meters (m.s.l.) January 1941

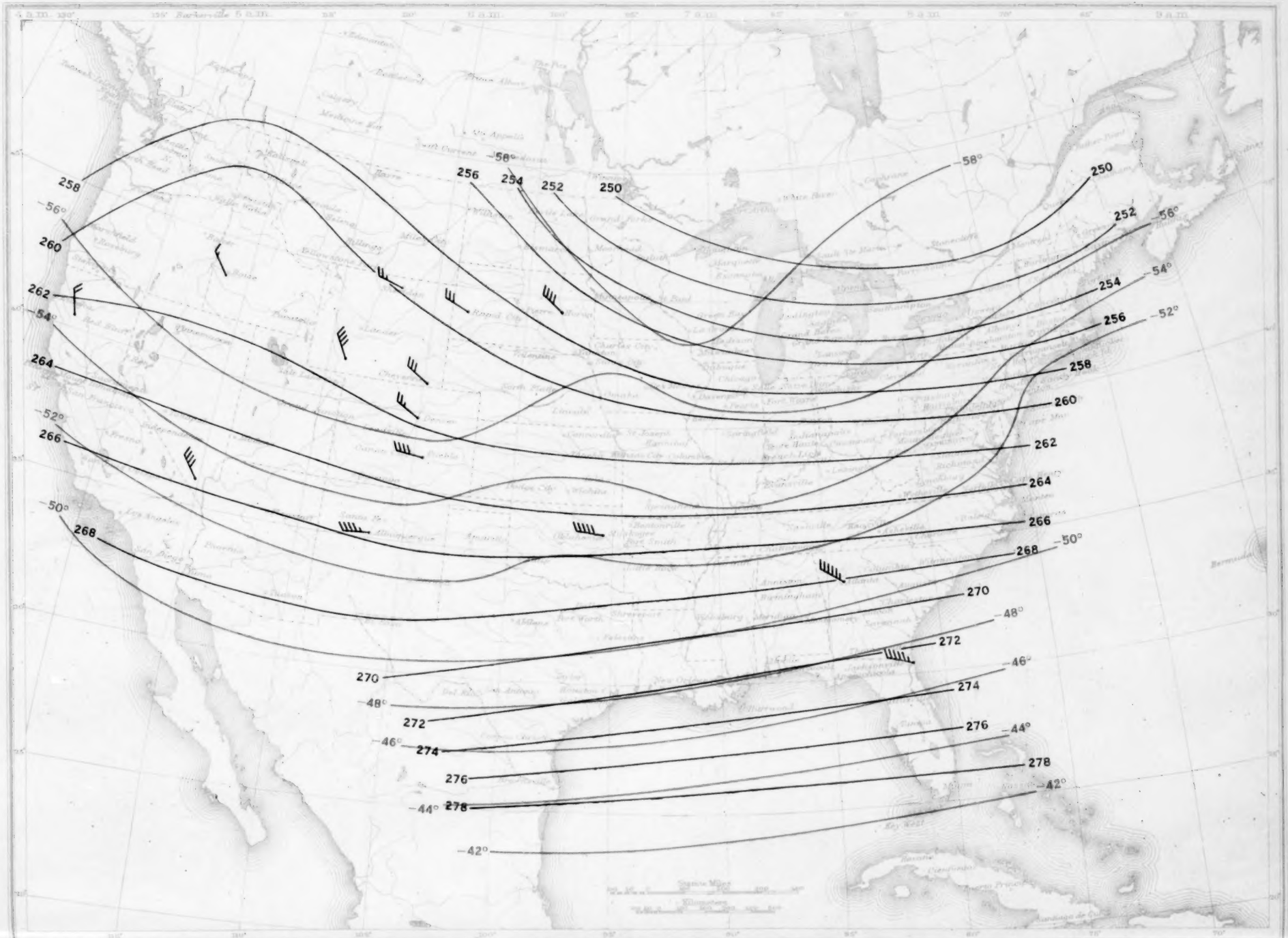
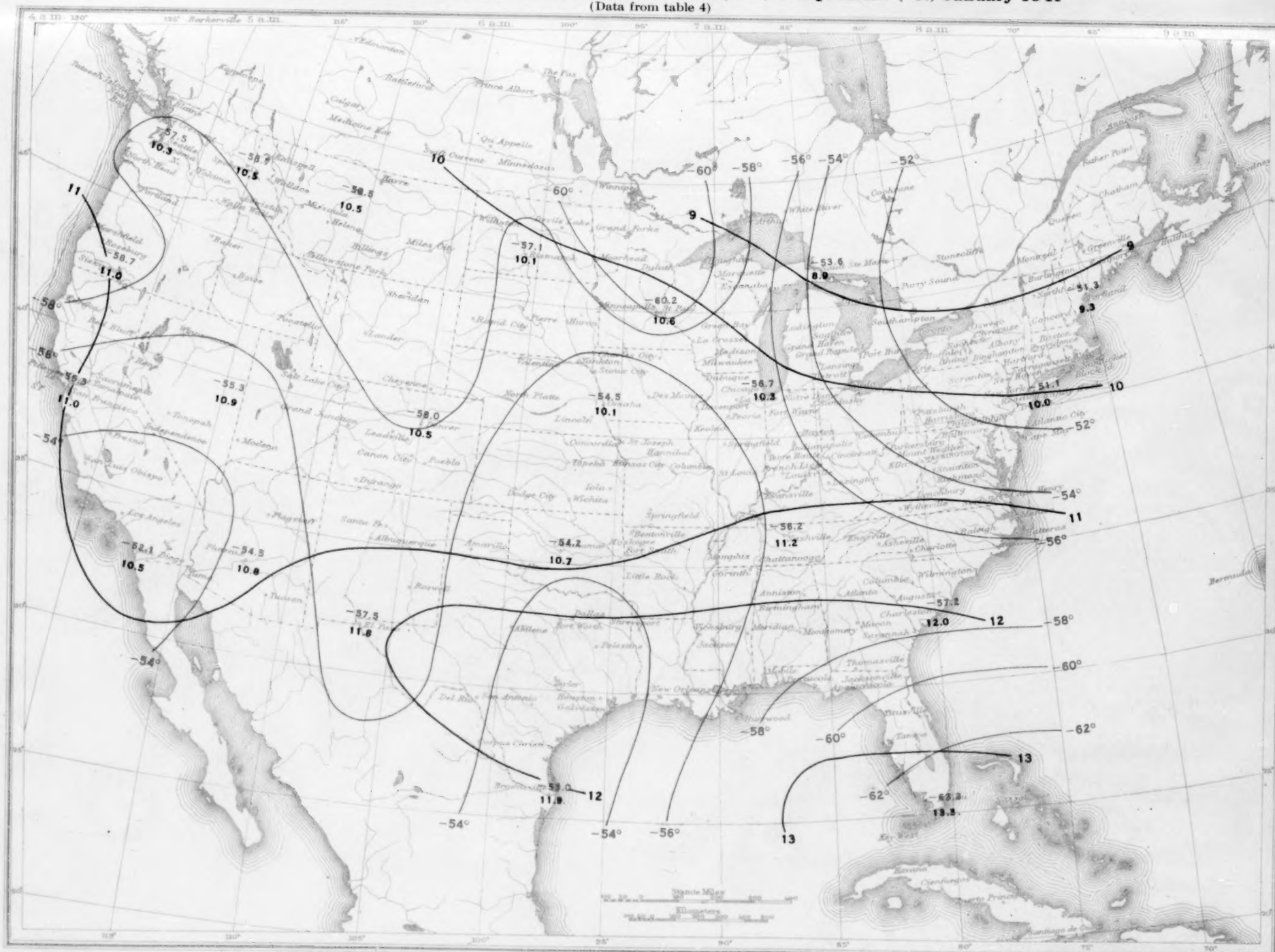


Chart XIII. Mean Tropopause Data. Altitude (km.) (m.s.l.) Temperature (°C.) January 1941

Chart XIII. Mean Tropopause Data, Altitude (km.) (m. s. l.) Temperature (°C.) January 1941

(Data from table 4)